FINAL DESIGN REPORT
FOR PHASES I AND II OF THE
SILVER CREEK DRAINAGE PROJECT

Lewis & Clark County, Montana

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1.0 INTRODUCTION

The Silver Creek Drainage Project is located approximately 15 miles north of Helena, Montana. The headwaters of the basin are located on the east side of the Continental Divide near the historic mining community of Marysville and the project encompasses a portion of the Marysville Mining District. This document presents the Final Design for the reclamation of the abandoned tailings and selected waste rock and placer tailings piles included in the Silver Creek Drainage Project.

The data used for this Final Design report were presented in the Phase I and Phase II site characterization reports and the Expanded Engineering Evaluation/Cost Analysis (EEE/CA) report for the Silver Creek Drainage Project (DEQ-MWCB/Olympus, 2003a, 2003b and 2003c, respectively) prepared by Olympus Technical Services, Inc. (Olympus) and submitted to the Montana Department of Environmental Quality-Mine Waste Cleanup Bureau (DEQ-MWCB). The project area includes the Drumlummon mine, millsite and tailings areas, the Goldsil millsite and tailings areas, the Upper, Middle and Lower Pond areas, the Silver Creek placer tailings area and the Silver Creek stream corridor.

The project area is located in Lewis & Clark County, Montana within Sections 35 and 36, Township 12 North and Range 6 West; Sections 31, 32, 33 and 34, Township 12 North, Range 5 West; Sections 1, 2, 3 and 5, Township 11 North, Range 5 West; and Sections 6, 7, 8, 16, 17, and 21, Township 11 North, Range 4 West, Montana Principal Meridian (Figure 1-1). This figure shows the approximate boundaries of the project. Figure 1-2 is a composite of aerial photographs taken in 1995 showing an overview of the Silver Creek Drainage Project area.

2.0 SITE CHARACTERIZATION SUMMARY

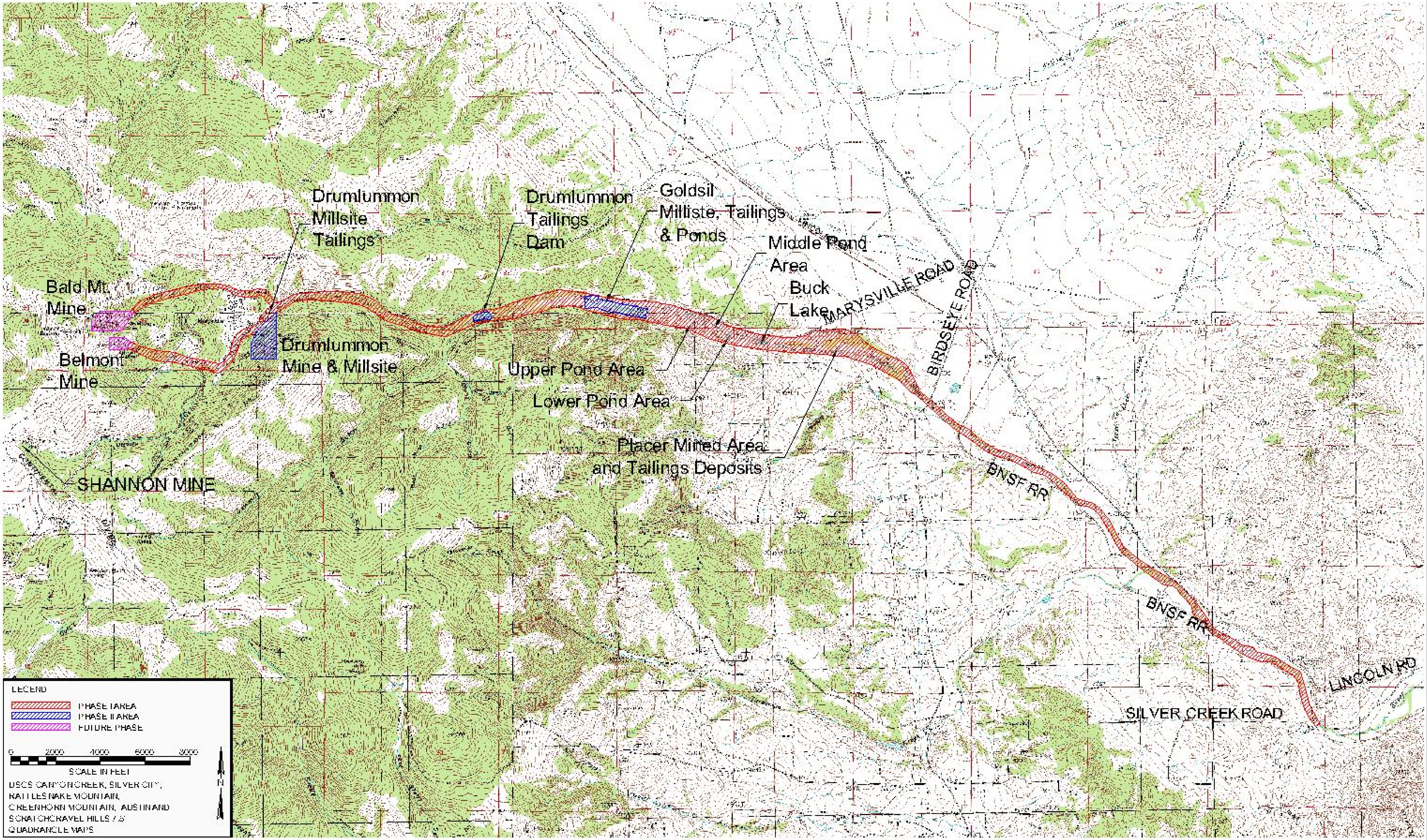
Site characterization results for the Silver Creek Drainage Project were compiled in the Phase I and Phase II summary reports and the EEE/CA (DEQ-MWCB/Olympus, 2003c) for the site. The following is brief summary of the waste source volumes, chemistry and the contaminants of concern identified for waste sources and surface water in Silver Creek.

2.1 WASTE SOURCES

2.1.1 Location and Volumes

Table 2-1 summarizes the location, acreage, average thickness and volume of the mill tailings and mine waste rock sources in the Silver Creek Drainage Project. Mill tailings are the principal waste source in the Silver Creek drainage. The majority of the mill tailings occur in seven areas in the Silver Creek drainage. These tailings areas in order from the largest to smallest volume are identified as follows: Goldsil tailings, Drumlummon tailings, Goldsil millsite tailings, Upper Pond Area, Lower Pond Area, Middle Pond Area, and Drumlummon millsite tailings.

Four waste rock piles, WR-1 through WR-4, are associated with the Drumlummon mine and millsite areas. The two small waste rock piles, WR-1 and WR-2, are located at the Drumlummon Mine. The Drumlummon millsite contains the majority of the waste rock (>96% of total volume) in the Silver Creek drainage.



NO.	REVISION DESCRIPTION	BY	DATE	DESIGN:	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	SILVER CREEK DRAINAGE PROJECT OVERVIEW MAP	FIGURE 1-1
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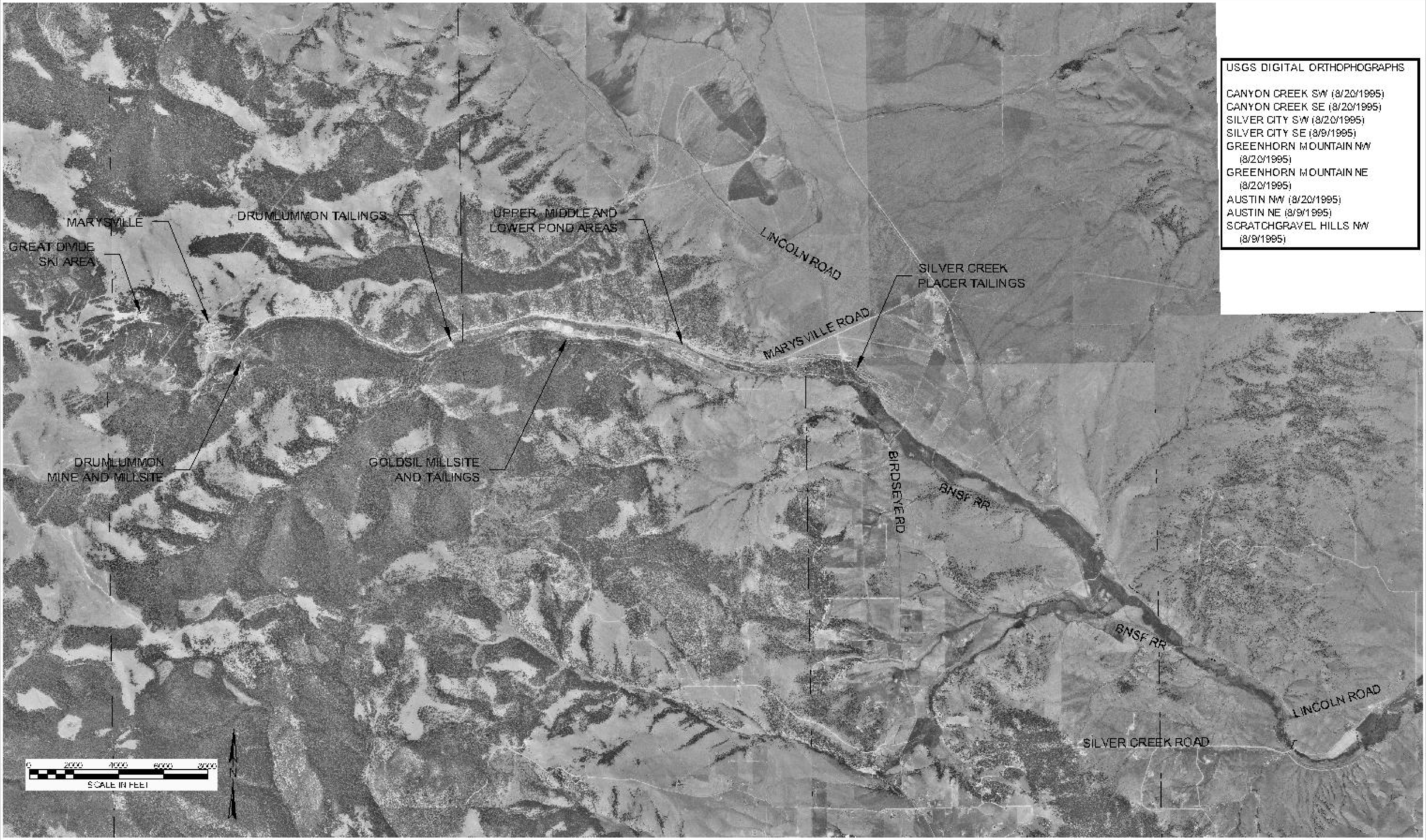

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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE CHARACTERIZATION
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

AERIAL PHOTOGRAPH OF THE SILVER CREEK DRAINAGE

FIGURE 1-2

Table 2-1. Summary of General Information for Silver Creek Drainage Project Mill Tailings and Mine Waste Rock Sources

Waste Source Identification	Area (Acres)	Location (Section, Township, Range)	Average Thickness Estimated (feet)	Waste Volume (cubic yards)	Waste Volume Subtotal (cubic yards)
Goldsil tailings area		SE¼ Sec 33, T12N, R5W; SW¼ Sec 34, T12N, R5W			
Main Tailings	18.68		15.2	458,430	
Lined Pond Area Tailings	1.97		1.1	3,440	
Lined Pond Berm Tailings	1.87		2.5	7,550	469,420
Drumlummon tailings	5.45	SE¼ Sec 32, T12N, R5W	6.8	59,780	59,780
Goldsil Millsite area tailings		SW¼ Sec 34, T12N, R5W			
Block 1 - Lined Ditch	0.41		1.0	660	
Block 2 - Lobe North of Ditch	0.12		3.8	740	
Block 3 - Mill Vat Tank Area	0.43		1.7	1,200	
Block 4 - Mill Ramp Area	1.07		11.6	19,870	
Block 5 - Mill Tanks	0.05		<1.5	80	22,550
Upper Pond Area tailings	2.23	SE¼ Sec 34, T12N, R5W	6.0	20,720	20,720
Lower Pond Area tailings	1.77	NE¼ Sec 3, T11N, R5W	6.2	17,670	17,670
Middle Pond Area tailings	1.97	SE¼ Sec 34, T12N, R5W; NE¼ Sec 3, T11N, R5W	<5.0	11,110	11,110
Drumlummon Millsite tailings		SE¼ Sec 36, T12N, R6W			
Mill Foundation				50	
TP-1	1.22		2.3	4,530	
TP-2	0.54		1.8	1,540	
TP-3	1.04		2.7	4,450	10,570
Drumlummon Mine					
Waste Rock Pile WR1	0.19	SE¼ Sec 36, T12N, R6W	4.7	1,460	
Waste Rock Pile WR2	0.34	SE¼ Sec 36, T12N, R6W	5.4	2,960	4,420
Drumlummon Millsite					
Waste Rock Pile WR3	0.45	SE¼ Sec 36, T12N, R6W	4.8	3,500	
Waste Rock Pile WR4	2.77	SE¼ Sec 36, T12N, R6W	24.8	110,510	114,010
				Total Tailings	611,820
				Total Waste Rock	118,430

2.1.2 Chemistry Results

The chemistry of the mill tailings was determined from qualitative to semi-quantitative X-ray fluorescence spectrometry of 200 samples and the quantitative laboratory analysis of 37 composite samples. The tailings were analyzed for up to 15 parameters including silver (Ag), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), lead (Pb), manganese (Mn), nickel (Ni), antimony (Sb), zinc (Zn), total cyanide (CN) and paste pH. The tailings laboratory chemistry results are summarized in Table 2-2. The average tailings element concentrations indicate that the following elements are significantly elevated (>3x background soil mean concentration) in one or more of the tailings piles: Ag, Cd, Cu, Hg, Pb and Zn. The total cyanide concentration in the tailings ranges from <0.05 to 24.8 mg/Kg and is most elevated in the Drumlummon millsite tailings. The following contaminants of concern were identified in one or more of the tailings piles from the human health and ecological risk assessment conducted during the EEE/CA (DEQ-MWCB/Olympus, 2003c): Ag, Cd, Cu, Hg, Pb, Sb, Zn and total CN.

The chemistry of the waste rock was determined from qualitative to semi-quantitative X-ray fluorescence spectrometry of 11 samples and the quantitative laboratory analysis of 2 composite samples. The waste rock was analyzed for up to 14 parameters including Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Pb, Mn, Ni, Sb, Zn, and paste pH. The waste rock laboratory chemistry results (WR-1 through WR4) are summarized in Table 2-2. The average waste rock element concentrations indicate that Pb and Hg were significantly elevated (>3x background soil mean concentration) in the Drumlummon millsite waste rock piles (WR3 and WR4), but not in the Drumlummon mine waste rock piles (WR1 and WR2).

The following contaminants of concern in waste rock were identified from the human health and ecological risk assessment conducted during the EEE/CA (DEQ-MWCB/Olympus, 2003c): Hg and Pb. These contaminants of concern were only identified in the Drumlummon millsite waste rock piles (WR3 and WR4).

2.1.3 Acid/Base Accounting Results

Much of the mill tailings in the Silver Creek drainage was generated from mining operations dating from the late 1800's to the early 1900's. The Goldsil operation that occurred in the late 1970's only reprocessed tailings from these earlier operations. Acid-base accounting via the modified Sobek method was conducted on ten composite tailings samples representative of the Goldsil tailings (including the Goldsil millsite area tailings) and the Drumlummon tailings. These tailings areas contain the majority (>90%) of the total tailings present in the project area. The acid-base potential results for the Goldsil tailings and Drumlummon tailings range from +64 to +109 t/1000t $CaCO_3$ suggesting that these tailings have very limited acid generation potential. Field evidence supports this interpretation because, outside of some iron-oxidized tailings evident in the Drumlummon tailings, the mill tailings and Silver Creek do not display characteristics indicative of acid rock drainage.

Two composite samples representative of waste rock piles WR-1 through WR-4 were also evaluated for acid-base accounting via the modified Sobek method. The acid-base potential results for WR1/WR2 and WR3/WR4 are +158 t/1000t $CaCO_3$ and +75 t/1000t $CaCO_3$, respectively. The results suggest that these rock piles are most likely not acid generating waste.

Table 2-2. Summary of Chemistry Results For Mill Tailings and Mine Waste Rock Sources
(concentrations: pH in standard units; all others mg/Kg)

	Goldsil Tailings					Drumlummon Tailings					Upper Pond Tailings Area				
	Minimum	Maximum	Mean	Mean/ Bkgd	CoC	Minimum	Maximum	Mean	Mean/ Bkgd	CoC	Minimum	Maximum	Mean	Mean/ Bkgd	CoC
Ag	9	43	19.3	>7.7x	Yes	10	21	16.4	6.6x	Yes	NA				
As	22	45	31.8	1.5x		10	20	11.7	0.6x		27	54	40.5	1.9x	
Ba	35	75	35	0.3x		35	56	47.4	0.3x		NA				
Cd	2	4	3.1	>6.2x	Yes	<1	<1				3	4	3.5	>7.0x	Yes
Cr	<5	6		0.28x		7	11	7.1	0.6x		NA				
Cu	114	240	171.2	5.0x	Yes	23	79	62.4	1.8x		164	301	232.5	6.8x	Yes
Fe	4970	9720	4970	0.5x		6380	9100	7684.0	0.6x		NA				
Hg	18	96	50.7	>101.4	Yes	<1	1		b	Yes	32	140	86.0	>172x	Yes
Mn	551	889	699.4	1.4x		386	512	438.2	0.9x		NA				
Ni	<5			0.30x		<5	7		c		NA				
Pb	122	268	181.8	16.1x	Yes	37	79	54.4	4.8x	Yes	163	331	247.0	21.9x	Yes
Sb	12	17	15.0	3.1x	Yes	<5	8	5.0	1.0x		NA				
Zn	237	557	354.3	5.2x	Yes	64	124	102.6	1.5x		334	686	510.0	7.4x	Yes
Total CN	<0.05	21.1	3.5	a	Yes	<0.5	<0.5		a	Yes	0.5	1	0.8	a	Yes
pH	7.6	8.1	7.9			7.7	7.9	7.9			7.9	8.0	8.0		

	Middle Pond Tailings Area					Lower Pond Tailings Area					Drumlummon Millsite Tailings				
	Minimum	Maximum	Mean	Mean/ Bkgd	CoC	Minimum	Maximum	Mean	Mean/ Bkgd	CoC	Minimum	Maximum	Mean	Mean/ Bkgd	CoC
Ag	NA					NA					8	8	8	3.2x	Yes
As	20	27	23.5	1.1x		27	29	28.0	1.3x		18	41	28.0	1.3x	
Ba	NA					NA					88	88	88	0.6x	
Cd	<1	3	1.9	>3.8x	Yes	2	2	2.0	>4.0x	Yes	<2	<2			
Cr	NA					NA					11	11	11	0.92x	
Cu	79	131	103.8	3.0x	Yes	115	135	125.0	3.7x	Yes	53	195	97.6	2.9x	
Fe	NA					NA					10600	10600	10600	0.77x	
Hg	7	26	18.8	>37.6x	Yes	27	37	32.0	>64x	Yes	<1	9	4.1	>8.2x	Yes
Mn	NA					NA					474	474	474	0.94x	
Ni	NA					NA					<5	<5			
Pb	78	147	110.8	9.8x	Yes	107	132	119.5	10.6x	Yes	74	173	117.2	10.4x	Yes
Sb	NA					NA					10	10	10	2.1x	
Zn	166	262	217.3	3.2x	Yes	231	280	255.5	3.7x	Yes	78	335	181	2.6x	
Total CN	4.1	23.9	9.7	a	Yes	2	5	3.5	a	Yes	<0.2	24.8	5.70	a	Yes
pH	7.4	7.7	7.6			8.0	8.1	8.1			7.3	8.2	7.82		

Table 2-2. Summary of Chemistry Results For Mill Tailings and Waste Rock (continued)
(concentrations: pH in standard units; all others mg/Kg)

	Drumlummon Mine and Millsite Waste Rock				
	Minimum	Maximum	Mean	Mean/ Bkgd	CoC
Ag	<5	5	3.75	1.5x	
As	7	27	17.0	0.8x	
Ba	52	107	79.5	0.6x	
Cd	<1	<1			
Cr	10	14	12.0	1.0x	
Cu	52	53	52.5	1.5x	
Fe	12100	15000	13550	1.0x	
Hg	<1	2	1.25	2.6x	Yes*
Mn	416	442	429	0.9x	
Ni	8	9	8.5	0.9x	
Pb	12	67	39.5	3.5x	Yes*
Sb	<5	6	4.25	0.9x	
Zn	46	86	66	1.0x	
Total CN	NA				
pH	8.1	8.6	8.4		

Note:
CoC= Contaminant of concern based on risk assessment (DEQ-MWCB/Olympus, 2003c)
NA = Not analyzed
a = Analyte total cyanide was not analyzed in background soils
b = Analyte Hg was detected at a maximum of 1 mg/Kg in less than 50% of samples
c = Analyte Ni was detected at a maximum of 7 mg/Kg in less than 50% of samples
* CoC in Drumlummon Millsite waste rock only
Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

2.1.4 TCLP Results

Based on the laboratory analytical results for the mill tailings, splits of composite samples were selected for Toxicity Characteristic Leaching Procedure (TCLP) metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) analysis. The sample results were summarized in the EEE/CA (DEQ-MWCB/Olympus, 2003c) report. Chemistry results for mill tailings show that mercury is the metal element of most concern in the Silver Creek Drainage Project area. Four composite mill tailings samples with elevated mercury concentrations (53 mg/Kg to 140 mg/Kg) were analyzed for TCLP and the results indicated that no elements exceeded the regulatory levels for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification. Selenium was the only analyte detected in the TCLP analyses for mill tailings and the concentrations were well within the regulatory limit. Splits of the two waste rock composite samples were also analyzed for TCLP metals and the results also indicated that no elements exceeded the regulatory levels for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification.

2.1.5 Summary of Surface Water Contaminants of Concern

A total of 173 surface water samples were collected during previous investigations from 74 reported location descriptions in the Silver Creek drainage basin. The sample results were summarized in the EEE/CA (DEQ-MWCB/Olympus, 2003c) report. A number of analytes (Table 2-3) were found to occasionally exceed either Federal water quality standards, Montana human health standards or Federal aquatic life standards in Silver Creek.

TABLE 2-3 SUMMARY OF SURFACE WATER QUALITY EXCEEDANCES FOR SILVER CREEK

Montana Human Health Standard	Acute Freshwater Aquatic Life Standard	Chronic Freshwater Aquatic Life Standard
Arsenic[1] (As)	Arsenic (As)	Arsenic (Cd)
Iron (Fe)	Cadmium (Cd)	Cadmium (Cd)
Manganese (Mn)	Copper (Cu)	Copper (Cu)
Mercury (Hg)		Iron (Fe)
		Lead (Pb)
		Total Cyanide (CN)
Notes:		

[1]Only below Birdseye Road; does not meet CoC criteria in waste sources.
Standards for metals in surface water are based upon the analysis of total recoverable metals (Circular WQB-7 Montana Numeric Water Quality Standards, 2002)
Standards where applicable are based on a hardness of 200 mg/l as $CaCO_3$ (note that average hardness for surface water concentration data is 190 mg/l CaCO3)

2.1.6 Summary of Ground Water Contaminants

A summary of previous groundwater sampling results of wells, springs and adit discharges was presented in the EEE/CA (DEQ-MWCB/Olympus, 2003c). In general most groundwater samples collected contained low concentrations of dissolved minerals and metals. Exceptions included elevated concentrations of total iron and total and dissolved manganese, in some cases.

As part of the Phase II site characterization of a potential mine/mill repository site, an evaluation of the depth and chemistry of shallow groundwater contained in the alluvial aquifer was undertaken in the Goldsil tailings area. Four monitoring wells were completed to assess shallow groundwater depths and water quality. A potentiometric map of the groundwater surface based on the December 4, 2002 static water level measurements is presented on Figure 2-1. The shallow groundwater flow direction is North 68° East at a gradient of 0.043 feet per foot. In this area, the shallow groundwater flow direction generally parallels the flow of Silver Creek. Water samples were collected from the four monitoring wells and a steel drum sump located along the toe of the existing lined tailings pond and analyzed for total and dissolved metal concentrations. A summary of the analytes exceeding regulatory standards is presented in Table 2-4.

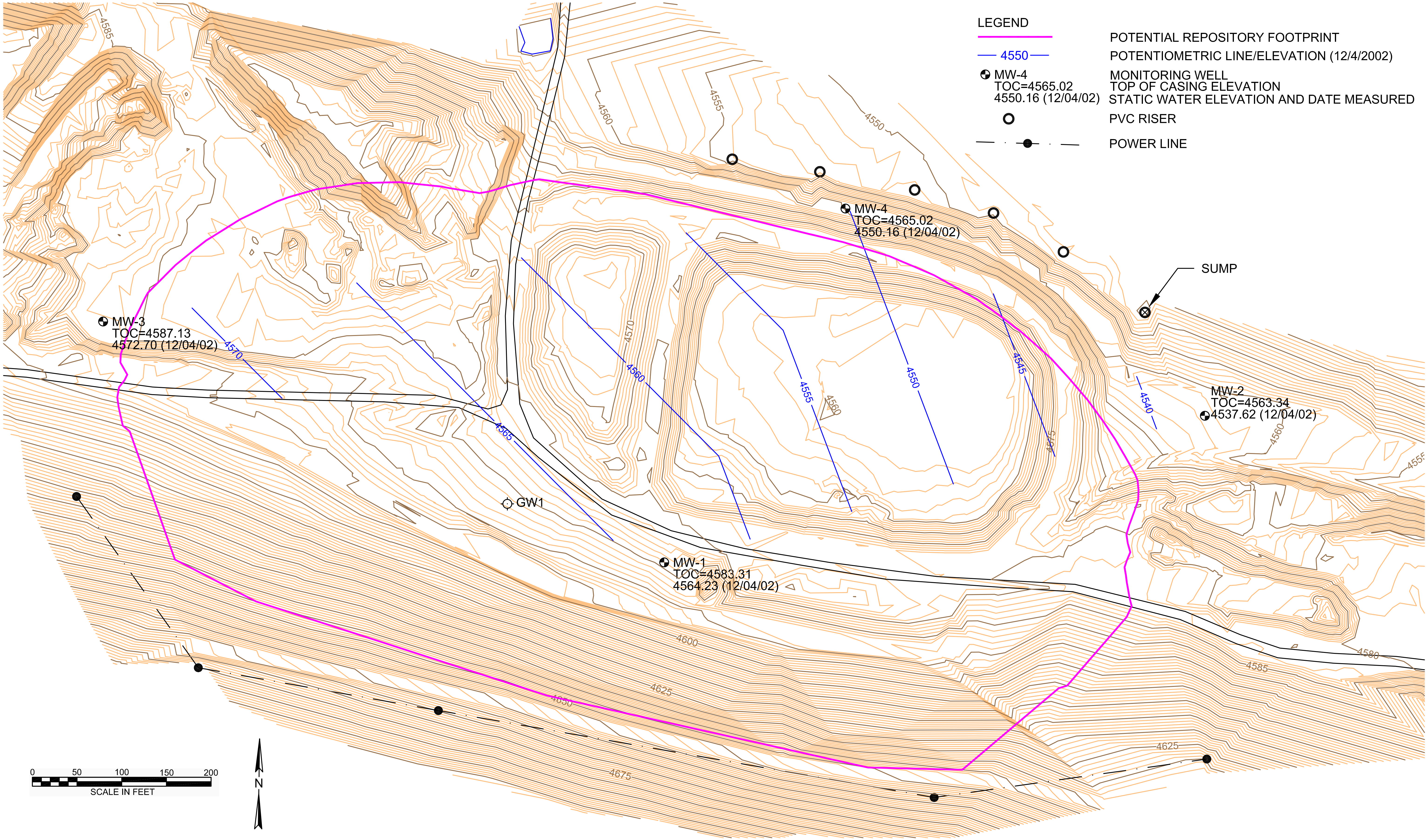
TABLE 2-4 SUMMARY OF GROUNDWATER QUALITY EXCEEDANCES FOR THE SILVER CREEK DRAINAGE AREA

Montana Human Health Standard[1]	Federal Safe Drinking Water Act Primary MCL[2]	Federal Safe Drinking Water Act Secondary MCL[2]
Arsenic (As)**	Arsenic (As)	Iron (Fe)
	Silver (Ag)*	Manganese (Mn)
	Mercury (Hg)*	Total Dissolved Solids (TDS)

Notes:
Summary based on well, sump and adit discharge water quality results
[1] Based on dissolved metal concentrations
[2] Based on total recoverable metal concentrations
*Exceedance only in steel drum sump water located near toe of lined tailings pond
**Exceedance in adit discharge only

2.1.7 Geotechnical Testing Results

Representative composite mill tailings samples were analyzed for geotechnical parameters to allow the evaluation of tailings compaction, settlement in the repository, and slope stability. The samples were composited based on waste source location, depth intervals and similarity of materials (i.e., sandy vs. clayey tailings zones). The samples were composited from the waste sources and depth intervals shown in Table 2-5. The seven composite mill tailings samples were submitted to Maxim Technologies, Inc. for geotechnical testing. The testing included moisture-density relations (i.e., standard Proctor, ASTM D698), consolidation (ASTM D2435) and direct shear (ASTM D 3080). This testing was completed to support the repository design. The moisture-density testing was completed to evaluate waste compaction and the consolidation and shear testing were completed to support settlement and slope stability analyses. Laboratory reports for the geotechnical testing are included in Appendix A. A summary of the geotechnical testing data is presented in Table 2-6.



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

GOLDSIL TAILINGS
MONITORING WELL LOCATION MAP
AND POTENTIOMETRIC SURFACE

FIGURE
2-1

TABLE 2-5 SUMMARY OF MILL TAILINGS GEOTECHNICAL COMPOSITE SAMPLES

Sample ID	Location	Description
DTS	Drumlummon tailings - sandy tailings	Composite of DT2-5.2-13.7'; DT3-0-3.7'; DT3-3.7-7.4'; DT5-0-8.9'; DT6-0-5.3'; DT8-0-5.8'; DT8-5.8-11.8'; DT15-0-4.7'; DT17-0-2'
DTC	Drumlummon tailings - clay/slime tailings	Composite of DT1-3-4.8'; DT1-4.8-7.8'; DT1-7.8-9.5'; DT4-0-5'; DT12-0-4.2'; DT12-4.2-6.4'; DT13-4.2-5.2'; DT15-4.7-6.6'
GDTH-S	Goldsil tailings - 0-15 feet deep	Composite of GTDH1-5-10'; GTDH1-10-15'; GTDH2-5-10'; GTDH2-10-15'; GTDH3-5-10'; GTDH3-10-15'; GTDH4-5-10'; GTDH5-5-10'; GTDH6-5-10'; GTDH7-5-10'; GTDH8-5-10'; GTDH9-5-10';
GDTH-D	Goldsil tailings 15 - 35 feet deep	Composite of GTDH1-29-34'; GTDH1-34-39'; GTDH2-25-30'; GTDH2-30-34'; GTDH3-25-30'; GTDH3-30-35'; GTDH4-30-33.1'; GTDH5-30-35'; GTDH6-30-35'; GTDH7-15-19.4'; GTDH8-20-23.15'; GTDH9-20-23'
GMT	Goldsil Millsite tailings	Composite of GM3-0-2.1'; GM5-0-2.4'; GM6-0-1.8'; GM7-0-2.3'; GM8-0-4.4'; GM9-0-1.5'; GM10-0-1.4'; GM13-0-11.5'; GM14-0-13.5'; GM15-0-14.6'; GM22-0-12.4"
UMLS	Upper, Middle and Lower Pond area sandy tailings	Composite of LP1-0-5'; LP1-5-9'; LP3-4-7.5'; LP7-0-3.8'; LP8-0-3'; UP7-0-3.8'; UP8-0-1.4'; MP2-0-5.8'; MP6-0-4.3'; MP15-0-4.7'; MP16-0-2.5'; MP20-0-3.7'
UMLC	Upper, Middle and Lower Pond area clay/slime tailings	Composite of LP1-9-14'; LP3-0-2.5'; LP4-5-10'; LP5-0-4'; LP5-4-9'; LP6-0-2.5'; LP6-5-8'; UP1-2.6-3.9'; UP2-0-4.5'; UP2-5.5-7'; UP3-1.6-5.1'; UP3-5.1-7.4'; UP8-9.4-10.5'; MP3-6.5-7.4'

TABLE 2-6 SUMMARY OF GEOTECHNICAL TESTING RESULTS

	Moisture-Density		Consolidation		Direct Shear	
Sample ID	Maximum Dry Density (pcf)	Optimum Moisture (%)	C_c	e_o	Cohesion (ksf)	Friction Angle (°)
DTS	98.0	21.0	0.08	0.875	0.03	33.1
DTC	104.5	19.5	0.31	0.758	0.04	28.6
GDTH-S	112.5	14.5	0.08	0.633	0.01	26.4
GDTH-D	109.5	13.5	0.06	0.677	0.01	32.4
GMT	99.5	19.0	0.15	0.847	0.03	32.3
UMLS	99.5	19.0	0.04	0.845	0.12	31.8
UMLC	101.5	21.0	0.13	0.81	0.08	28.5

C_c - Compression index
e_o - in-place void ratio

2.2 BORROW SOURCES

2.2.1 Cover Soil

Eight potential borrow sources for cover soil were evaluated as part of the Phase I reconnaissance site characterization (DEQ/Olympus, 2003a). These sources all consist of placer tailing overburden piles, which are deposited in long, linear piles. The material was most likely stripped with a dragline to allow access to the stream gravels/cobbles for processing with dredges or wash plants. The overburden-type placer tailings piles are fine-grained and have established stands of vegetation. Figure 2-2 shows the locations of the overburden piles that were evaluated during the Phase I reconnaissance characterization. The following are the mean concentration and enrichment relative to the background mean concentrations for each element.

Placer Tailings Mean Element Concentrations Compared to Background (quantitative laboratory results)

All Results in mg/kg

As	Cd	Cu	Hg	Pb	Zn	T CN
28.4	a	28.9	2.6	21.6	56.0	a
1.1x		*0.9x*	*>5.2x*	*1.9x*	*0.81x*	

a - Analytes Cd and total cyanide were not detected in placer tailings samples
Hg was not detected above detection limit in background soils

With the exception of mercury, the mean element concentrations are near mean background soil concentration or are not significantly elevated above background. The maximum mercury concentration that was observed in the placer tailings was 7 mg/Kg. Risk-based cleanup levels for mercury are 23 mg/Kg for soil for a residential use scenario and 440 mg/Kg for soil for a recreational use scenario (Tetra Tech, 1996).

The piles of particular interest, designated Borrow Source No. 1 (BS-1) and Borrow Source No. 2 (BS-2), are located to the south of the Upper and Lower Pond areas. Topographic surveys of these borrow sources were completed to provide more accurate estimates of the material quantity. In addition to these piles, three smaller piles (BS-2a, BS-2b and BS-2c) located north of main Borrow Source No. 2 pile, have subsequently become of interest and were included in the topographic survey.

Figure 2-3 shows the location of BS-1. This pile is approximately 1,300 feet long and is located along the southern perimeter of the Lower and Middle Pond areas. Based on the topographic survey, the volume of BS-1 is approximately 20,710 cubic yards.

Figure 2-4 shows the location of BS-2. This pile is approximately 1,100 feet long and extends from the lower Goldsil millsite access road to near the west end of the Upper Pond area. Based on the topographic survey, the volume of BS-2 is approximately 17,460 cubic yards. In addition to the main BS-2 pile, there are three additional smaller piles, designated BS-2a, BS-2b and BS-2c. Based on the topographic survey, the volumes of borrow sources BS-2a, BS-2b and BS-2c are approximately 2,930 cubic yards, 6,580 cubic yards and 1,710 cubic yards, respectively.

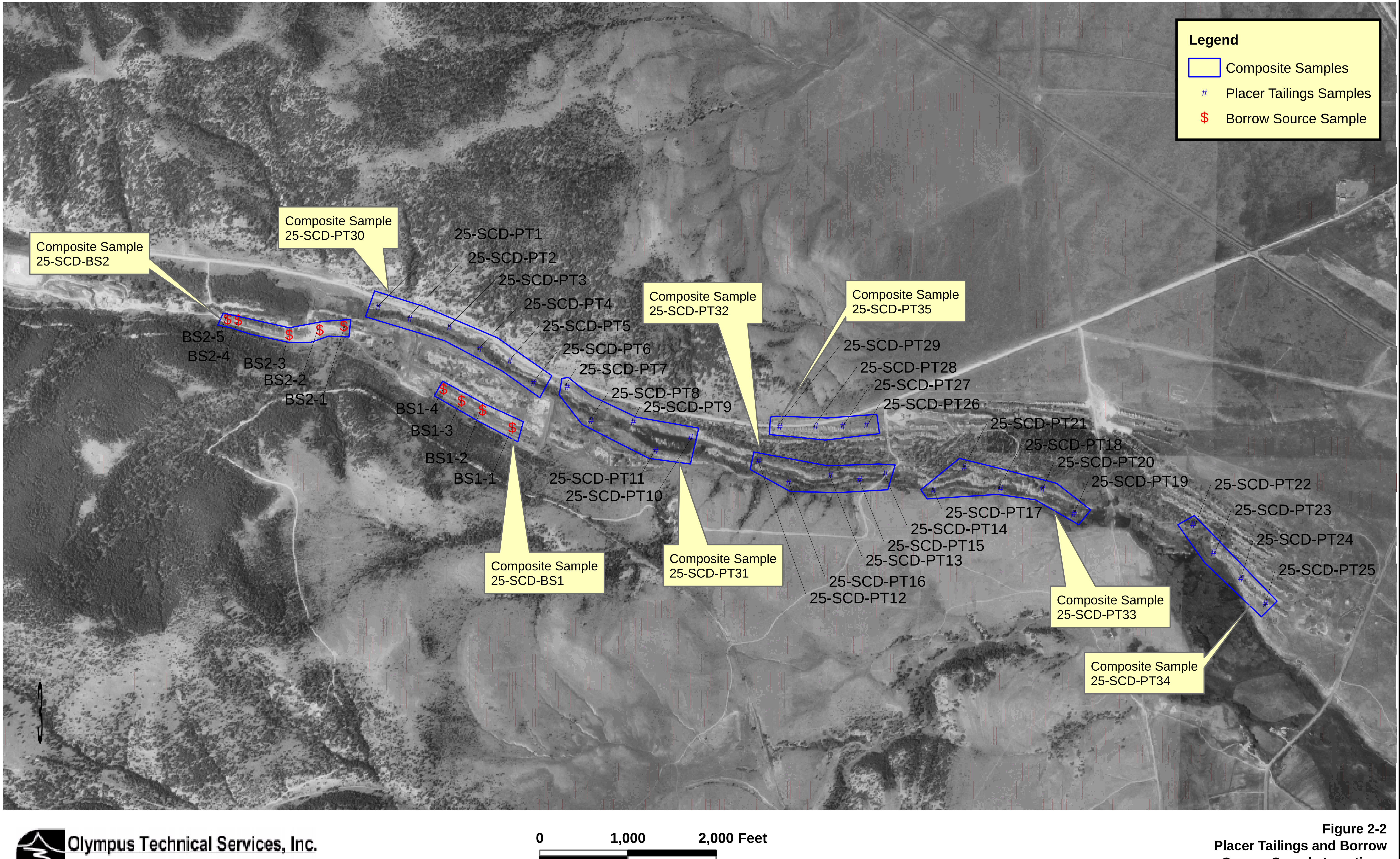

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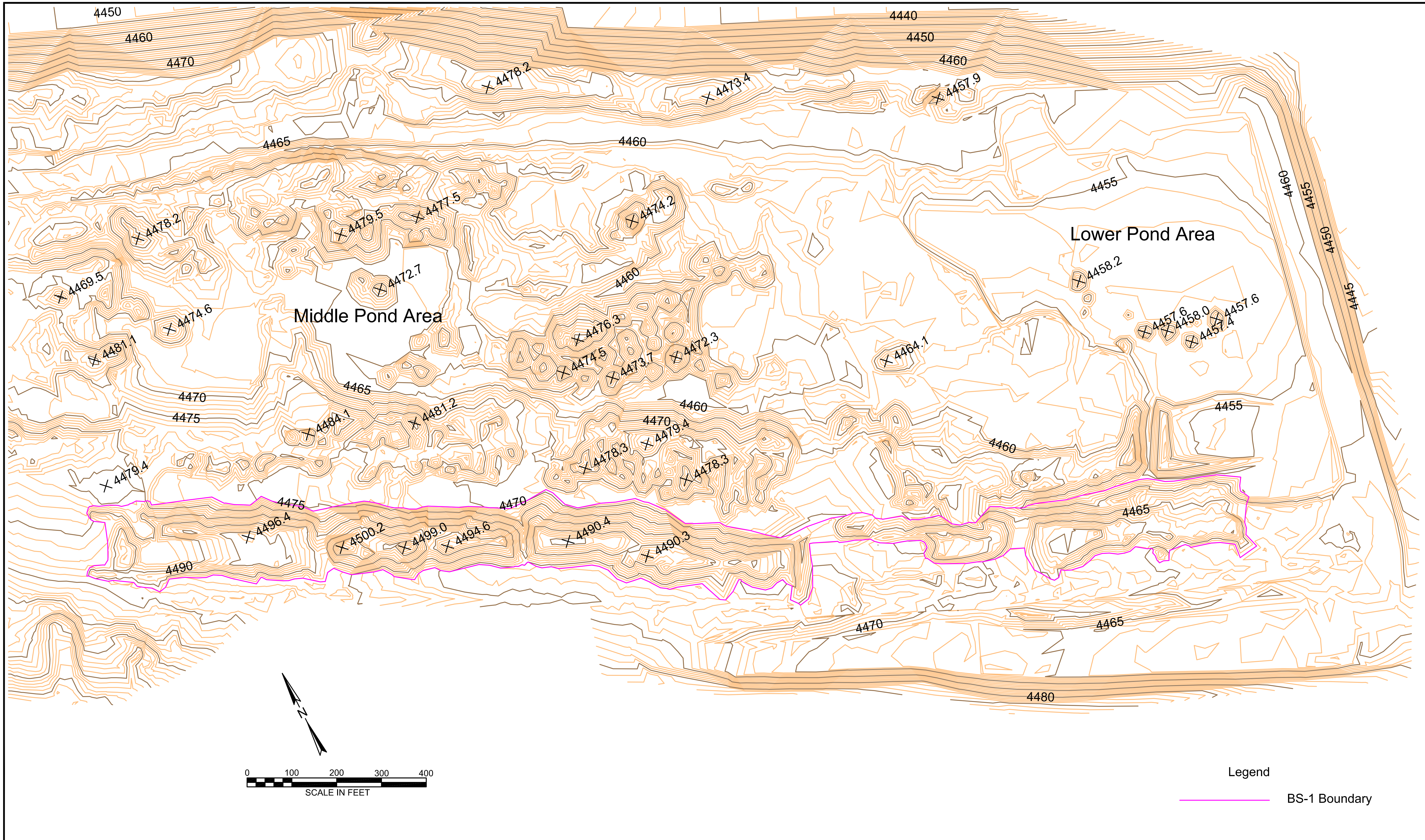
Figure 2-2
Placer Tailings and Borrow Source Sample Locations



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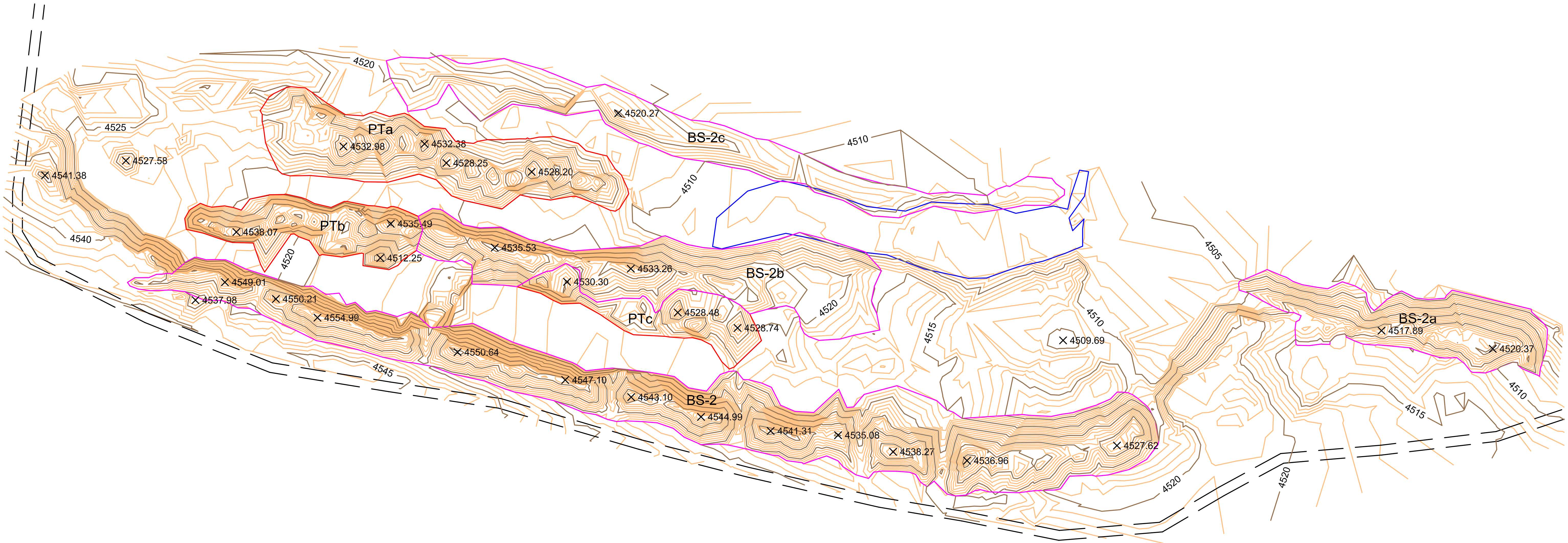
BORROW SOURCE BS-1
EXISTING TOPOGRAPHY

FIGURE
2-3



LEGEND

BS-2b	BORROW SOIL PILE
PTb	PLACER TAILINGS ROCK PILE
	WATER

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				APPROVED: KSR	DATE: 6/2004	JOB NO: A1416				
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The main access road to the Upper, Middle and Lower Pond area runs along the southern perimeter of BS-2 and continues along the southern perimeter of BS-1 and would provide easy access for removal and hauling of the borrow material. The combined cover soil from BS-1 and the BS-2 piles is approximately 49,390 cubic yards.

2.2.2 Riprap

Processed placer tailings piles in the vicinity of Borrow Source No. 2 were evaluated as a potential riprap source. Three separate processed placer tailings piles were included in the evaluation and the piles are designated at PT-a, PT-b and PT-c. Figure 2-3 shows the location and topography of the piles. Pile PT-a is located between borrow source piles BS-2b and BS-2c. The west end of pile PT-a has been graded out and it appears that part of the pile may have been removed. It is suspected that this was the source of rock that was used to stabilize the washout in the Drumlummon tailings dam in the early 1990's.

Based on visual observations of the surface of the piles, the largest rock in the piles is on the order of one foot in diameter. There may be some material that is larger in diameter than one foot, however, this size fraction is not common. The predominant particle size is in the small cobble (2.5 to 5 inches) and very coarse gravel (1.3 to 2.5 inches) range. The sand, silt and clay fractions were removed in the dredging or wash plant process and are not present in the piles. The rock is generally sub-rounded in shape. Because of the sub-rounded shape, the rock is not suitable for use as riprap on steep slopes. Riprap used on steep slopes should be angular, which has a greater angle of repose. Based on the size and shape of the rock, it may be useful as channel base material for reconstruction of Silver Creek through the Drumlummon tailings area.

Based on the topographic survey, the volume of pile PT-a is approximately 4,800 cubic yards. Piles PT-b and PT-c are intermingled with borrow source pile BS-2b. The piles were delineated for estimating the individual volumes based on the surface topography and field observation of the three piles. The volumes of piles PT-b and PT-c are approximately 2,900 and 1,800 cubic yards, respectively.

2.3 SUMMARY OF CULTURAL RESOURCE INVENTORIES

Cultural resource inventory and assessments were conducted on the Silver Creek corridor (DEQ-MWCB/GCM Services, Inc., 2003), the Argo and Goldsil Mills (DEQ-MWCB/Frontier Historical Consultants, 2003) and the Drumlummon Mine and Mills (DEQ-MWCB/Frontier Historical Consultants, 2003).

The Silver Creek corridor cultural resources identified a number of sites that were recommended for listing under the National Register of Historic Places (NRHP). The following summarizes the site name, site number, brief description and the listing criteria:

- Belmont City (24LC885; old Belmont town site) - criterion D
- 1878 Belmont Mill (24LC1823; quartz mill site) - criteria A and B
- Mayger and Cruse (24LC1830; placer trenches, tailings, ditches, historical artifacts, dams, reservoirs) - criterion D listing only based on Locus III area within site

- Sawmill Gulch Site (24LC1836; historical artifacts, habitation remains, flume remains, reservoir, ditches) - criterion D
- Northern Pacific Railroad (24LC1614; remains of railbed) - criterion A
- Placer Camp (24LC1841; cabin remains, platforms, artifacts also prehistoric lithics component) - criterion D
- Anderson Site (24LC1842; prehistoric site, dump, placers) - criterion D
- Silver City (24LC1844; building sites, structures mill remains) - criterion D
- Great Northern RR main line segment (24LC1641; active railroad, stone culvert) - criterion A
- Hardy/Gehring mill (24LC1846; historic agriculture, feed mill) - criterion C
- No site name (24LC1847; Prehistoric lithic scatter and camp?) - criterion D

The proposed reclamation plan will not impact any of the sites recommended in the Silver Creek corridor study for listing under the NRHP. The removal action related to mill tailings pile TP-3 is located near the northwestern extent of the Mayger and Cruse site. The critical area within this site that resulted in a criterion D listing is Locus III which may contain historical artifacts. The removal action planned for the Drumlummon millsite tailings pile TP-3 will occur near the western end of the Mayger and Cruse claim boundary that represents the cultural resources boundary for this site. However, the TP-3 removal action will not impact the critical area.

The cultural resources work recommended that the Argo Mill site portion of the Argo and Goldsil Mills site (24LC1858) be eligible as a milling site and as a historic landscape under the NRHP criteria A, B and C. The Argo Mill operated from 1897 to 1907 and reprocessed over 800,000 tons of original Drumlummon tailings via cyanide leaching. The significant features identified at the site consist of: a trestle for a narrow-gauge railroad; the trestle's terminus; an ore bin; a windless hub; a collapsed dock; water race; piers; flume and giant funnel; a wooden water tank; debris of the assay office; a collapsed structure; and the remains of a power house. The upper tailings piles were included in the Argo Mill site boundary and these tailings were also recommended for eligibility. With the exception of the upper tailings, all of the features of the Argo Mill site that were identified as eligible for NRHP listing are located outside of the area proposed for reclamation and would not be impacted.

The Drumlummon Mine and its associated mills contained within the Drumlummon Mine and Mills site (24LC1853) were recommended to be eligible as both a historic mine site and historic mining landscape for listing under the NRHP criteria A, B and C. The Drumlummon Mine was a rare example of a true bonanza gold mine that operated in the late 19th and early 20th centuries. Features remaining on the mine site include: a head frame, assay house, numerous adits and shafts, two powder magazines, collapsed blacksmith shop, collapsed cabin, a flume, compressor house, rock walls, an ore bin, an office building, mill foundations, footings and remnants of walls and areas of debris. In addition, the Drumlummon tailings located just downstream from Sawmill Gulch were identified as a feature of the Drumlummon Mine and Mills cultural resources site. With the exception of the Drumlummon tailings and some minor tailings located on a portion of the mill foundation, all of the features of the Drumlummon Mine and its associated mills recommended for eligibility under the NRHP are located outside of the area proposed for mill tailings reclamation and would not be impacted. The mill tailings reclamation plan will require removal of the Drumlummon tailings pile to a repository. Silver Creek currently flows through the Drumlummon tailings pile and these tailings required past emergency actions to control tailings releases to Silver Creek. The removal of the minor tailings volume associated with the mill foundation could be done in a manner so as to minimize impacts on the foundation.

3.0 ENGINEERING DESIGN

3.1 DESIGN OBJECTIVES

The Phase I and II site characterization activities showed that the principal waste sources associated with the Silver Creek Drainage Project that are contributing to environmental impacts are the mill tailings and to a much lesser degree the waste rock. The mill tailings are elevated in metals/metalloids including: antimony, cadmium, copper, lead, mercury, silver, zinc and cyanide (concentrations greater than three times background). The Drumlummon millsite waste rock piles (WR-3 and WR-4) are elevated in lead and mercury.

A risk assessment was completed for the EEE/CA (DEQ-MWCB/Olympus, 2003c). The risk assessment showed that the greatest risk to human health and the environment from waste sources associated with Phases I and II of the Silver Creek Drainage Project are the tailings piles via the direct contact, surface water and air exposure pathways. Based on the risk assessment, ingestion of mercury via contaminated fish is the principal contaminant of concern for human health, while copper, lead, and mercury are the principal contaminants of concern for ecological exposures.

While elevated mercury concentrations were observed in the Silver Creek stream sediments, mass calculations show that the amount of mercury in stream sediment is minor compared to that present in the known waste sources. The mass of mercury in Silver Creek stream sediments from just above Marysville to the intersection with Silver Creek Road is estimated as less than 200 pounds. The mass of mercury in the mill tailings and waste rock piles is approximately 75,200 pounds. The vast majority (over 67,300 pounds) of mercury is contained in the Goldsil tailings pile.

The tailings piles are located in or near the Silver Creek stream drainage. The tailings piles are currently subject to erosion and infiltration of surface water, which contributes metals loading to Silver Creek surface water and stream sediment. Based on this evaluation, the objective of the design for Phases I and II of the Silver Creek Drainage Project is to provide a means for controlling the sources of contaminants that are impacting Silver Creek. Removal of the tailings from the drainage to an engineered repository would provide protection from the existing erosion and infiltration problems with a high degree of overall risk reduction.

A number of reclamation alternatives for the Silver Creek drainage were evaluated in the EEE/CA process. These alternatives are presented in Table 3-1. Of these 16 alternatives, five were evaluated in detail, including: Alternative 1, Alternative 3, Alternative 4, Alternative 7b, Alternative 7c and Alternative 8. Alternatives 2, 7a and 7b address the mill tailings, while Alternatives 4 and 8 address waste rock piles.

TABLE 3-1 RECLAMATION ALTERNATIVES FOR PHASES I AND II OF THE SILVER CREEK DRAINAGE PROJECT

Alternative	Description
1	No Action
2	Institutional Controls
3	Consolidation/In-Place Containment of Tailings
4	In-Place Containment of Waste Rock
5a	Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area
5b	Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area
5c	Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area
6a	Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Lower Pond Area
6b	Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Lower Pond Area
6c	Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Lower Pond Area
7a	On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area
7b	On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area
7c	On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area
8	Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits
9	Off-Site Disposal of Tailings in a Permitted Solid Waste Disposal Facility
10	Off-Site Disposal of Tailings in a RCRA-Permitted Hazardous Waste Disposal Facility

None of the tailings or waste rock piles exceeded TCLP regulatory levels for metals. Acid base accounting results and field evidence indicates that the tailings and waste rock are probably not acid generating. The favorable acid base accounting and TCLP data support the use of an unlined repository with a multi-layered cap to control water infiltration.

Based on the conclusions of the EEE/CA detailed analysis and comparative analysis of alternatives, Alternative 7c - On-Site Disposal in a Constructed Unlined Repository with a Multi-Layered Cap was selected as the preferred alternative for reclamation of the tailings associated with Phases I and II of the Silver Creek Drainage Project. This alternative is considered the most appropriate and cost-effective means to reduce risk to human health and the environment to an acceptable level. In summary, the reclamation strategy for Alternative 7c involves removing the tailings sources associated with Phases I and II of the Silver Creek Drainage Project and disposing these wastes in a constructed unlined repository with a multi-layered cap. The sources to be disposed in the repository include the Drumlummon millsite tailings piles, the Drumlummon tailings, the Goldsil tailings and the Upper, Middle and Lower Pond tailings areas. The repository would be constructed in the Goldsil tailings in an area that encompasses the existing lined tailings pond and adjacent areas to the south and west. The proposed repository site is located on a relatively flat bench above Silver Creek and would be constructed adjacent to the existing hillside on the south side of Silver Creek. Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the tailings. After the repository construction, waste excavation, and waste placement are complete, the excavated areas would be revegetated. A runon control ditch would be constructed in the area of the repository to divert runoff away from the repository cap. Barbed-wire fencing would be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. A woven-wire fence would be constructed around the repository to limit access.

3.2 WASTE REMOVAL PLANS

Tailings and impacted soils will be excavated from the known waste source areas associated with Phases I and II of the Silver Creek Drainage Project site characterization and placed in an on-site, unlined repository with a multi-layered cap. Areas of native soils beneath the tailings that are visually impacted (i.e., based on field indicators such as texture, iron oxide staining and light colored sediments which may be indicative of tailings) will also be excavated and placed in the repository. The waste sources proposed for removal to the repository include the Drumlummon millsite tailings, Drumlummon tailings, Goldsil tailings and Upper, Middle and Lower Pond Area tailings.

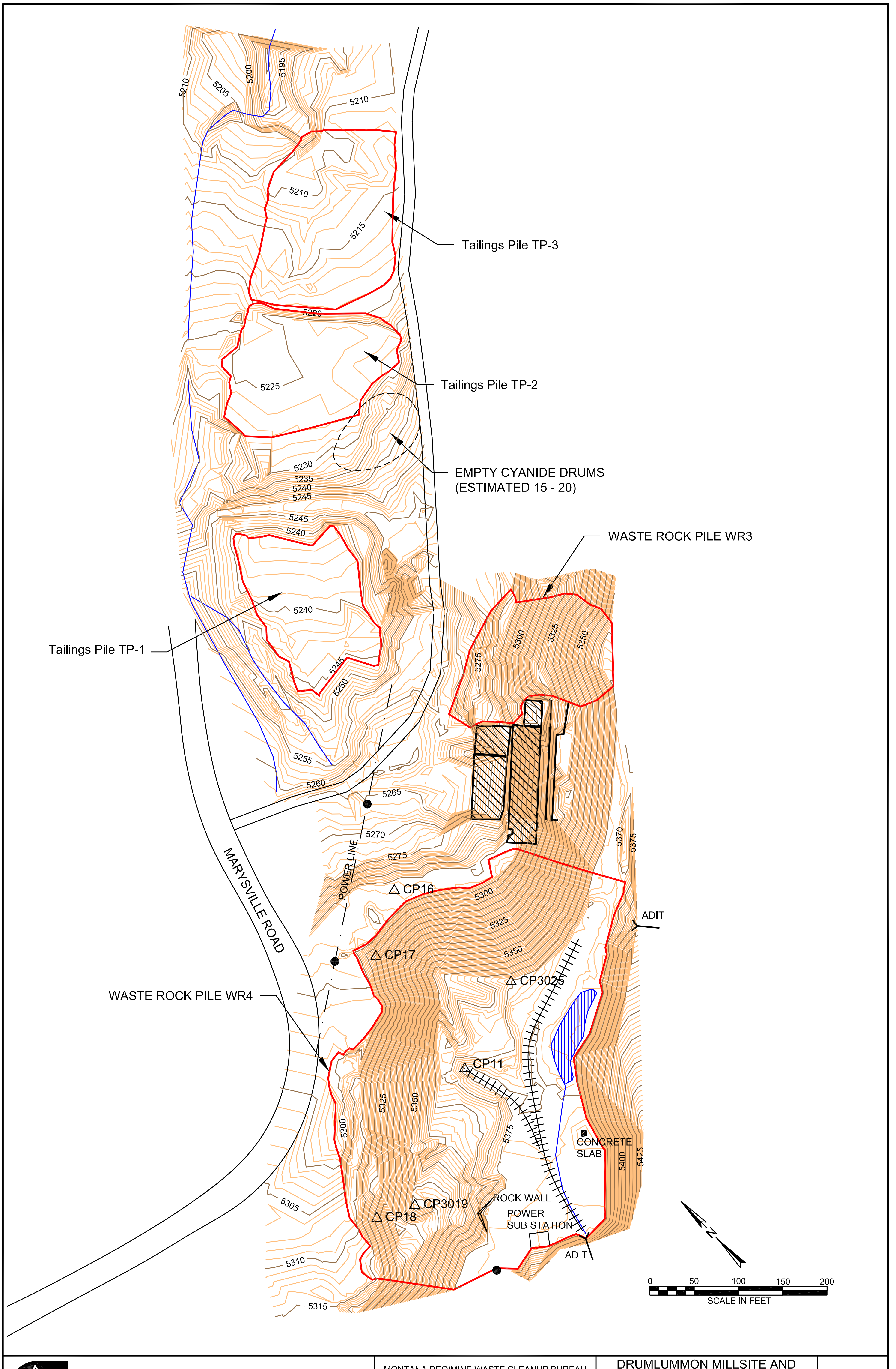
3.2.1 Drumlummon Millsite Tailings

The Drumlummon millsite tailings were discovered during the Phase I reconnaissance characterization, and as such were not previously surveyed. To support the design of the Silver Creek Drainage Project, the topographic survey of the Drumlummon millsite tailings was completed. Figure 3-1 shows the Drumlummon millsite area and the Drumlummon millsite tailings. The Drumlummon millsite tailings piles have been designated TP-1, TP-2 and TP-3.

Reclamation of the Drumlummon millsite tailings includes the excavation and removal of tailings piles TP-1, TP-2 and TP-3, and placement of these tailings in the Goldsil repository. There are a number of aspen trees that will require removal prior to excavation of the tailings. These trees will be staged in a convenient area near the tailings and will be spread over the reclaimed source areas to provide erosion protection and small game and bird habitat.

There is a berm that separates Silver Creek from tailings piles TP-1, TP-2 and TP-3. Silver Creek appears to have stabilized in its current location in the vicinity of tailings piles TP-1, TP-2 and TP-3 over several decades and will not be disturbed during the construction. The tailings pile TP-1, TP-2 and TP-3 source areas will be graded and revegetated after the tailings have been removed to the repository.

In addition to tailings piles TP-1, TP-2 and TP-3, there is an estimated 50 cubic yards of tailings located on the Drumlummon Mill foundation. These tailings will be removed from the mill foundation and placed in the repository along with the other Drumlummon millsite tailings. As described in Section 2.3, the Drumlummon Mine and associated mills are recommended to be eligible as both a historic mine site and historic mining landscape for listing on the National Register of Historic Places. As such, the tailings must be removed from the mill foundation in a manner that does not cause adverse impacts to the structure.



Olympus Technical Services, Inc.			MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA		DRUMLUMMON MILLSITE AND DRUMLUMMON MILLSITE TAILINGS (TP-1, TP-2 AND TP-3)		FIGURE 3-1
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3.2.2 Drumlummon Tailings

Tailings from the Drumlummon tailings area will be removed from their current location and placed in the Goldsil repository area. As shown on Figure 3-2, Silver Creek flows through the Drumlummon tailings pile. Therefore, the removal action will involve construction of a temporary stream diversion to divert Silver Creek around the Drumlummon tailings to facilitate removal of the tailings.

The tailings will initially be removed along the northern perimeter of the Drumlummon tailings to allow construction of a temporary stream diversion. After the diversion is constructed and Silver Creek is diverted, the remaining tailings will be removed and placed in the Goldsil repository. The existing road on the south side of Silver Creek that leads from the Goldsil tailings to the southeast corner of the Drumlummon tailings will be used as the haul road to the repository. This road will require little improvement, with the exception of the approach leading from the road down to the Drumlummon tailings. Construction of turnouts may be required to allow two-way traffic to pass. The estimated volume of Drumlummon tailings that will be placed in the Goldsil repository is 59,780 cubic yards, not including impacted native soils that may be encountered.

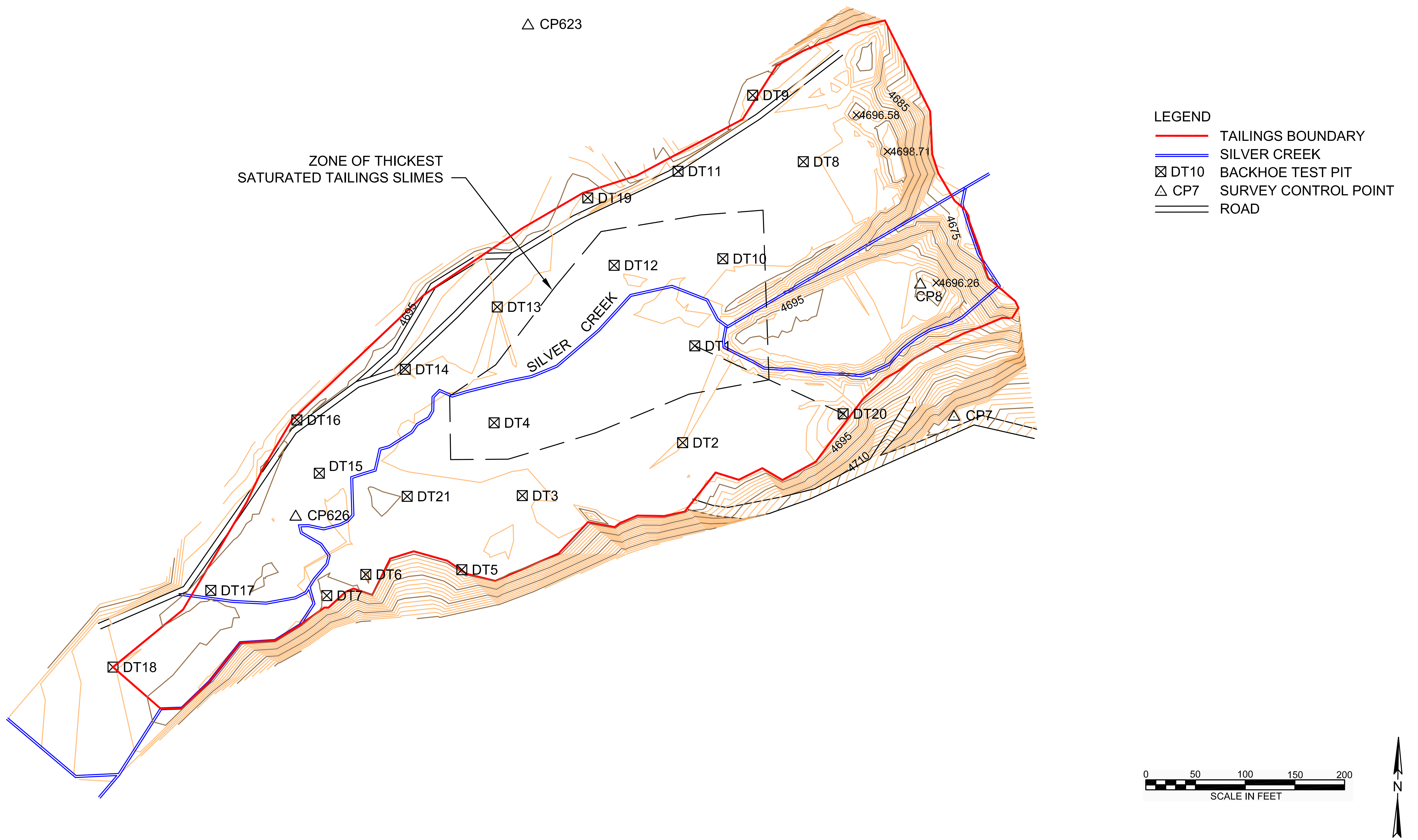
The Drumlummon tailings are well vegetated with grasses and other shrubs and trees including willows. There is some wood debris, consisting of wood cribbing, located on the dam face. Debris will be handled as described in Section 3.3. The wood cribbing will probably be burned on site or disposed of as solid waste, and will not be scattered as construction slash.

Because of prior erosion problems, Silver Creek has been diverted into two rock-lined channels within approximately 250 feet of the dam. An area of tailings between the two channels has been capped with rock to prevent erosion. The channel rock and rock cap are included in the tailings volume estimate, however, the rock will likely be salvaged and used as subgrade material for the stream channel reconstruction.

3.2.2.1 Silver Creek Hydrology

Design of the temporary stream diversion and the permanent stream reconstruction both require an evaluation of peak flows. The United States Department of Interior (USDI), Office of Surface Mining (OSM) recommends that temporary diversions of perennial and intermittent streams be designed for the 10-year peak flow (USDI, 1982). Similarly, OSM recommends that permanent diversions of perennial and intermittent streams be designed for the 100-year peak flow (USDI, 1982). Therefore, the temporary diversion will be designed for the 10-year flood and the reconstruction of Silver Creek after the waste removal will be designed for the 100-year flood.

The Drumlummon tailings are located on Silver Creek, immediately downstream of the confluence of Silver Creek and Sawmill Gulch. Peak discharges for Silver Creek were estimated using regional flood-frequency equations developed by Omang (1992). The regional equations for southwest Montana use the drainage basin area (10.31 square miles) and the percentage of the basin area above 6,000 feet in elevation (43.4 percent) to estimate peak discharge. The drainage basin is shown on Figure 3-3. Peak discharges estimated by regional flood-frequency equations for the Silver Creek drainage are shown in Table 3-2.



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

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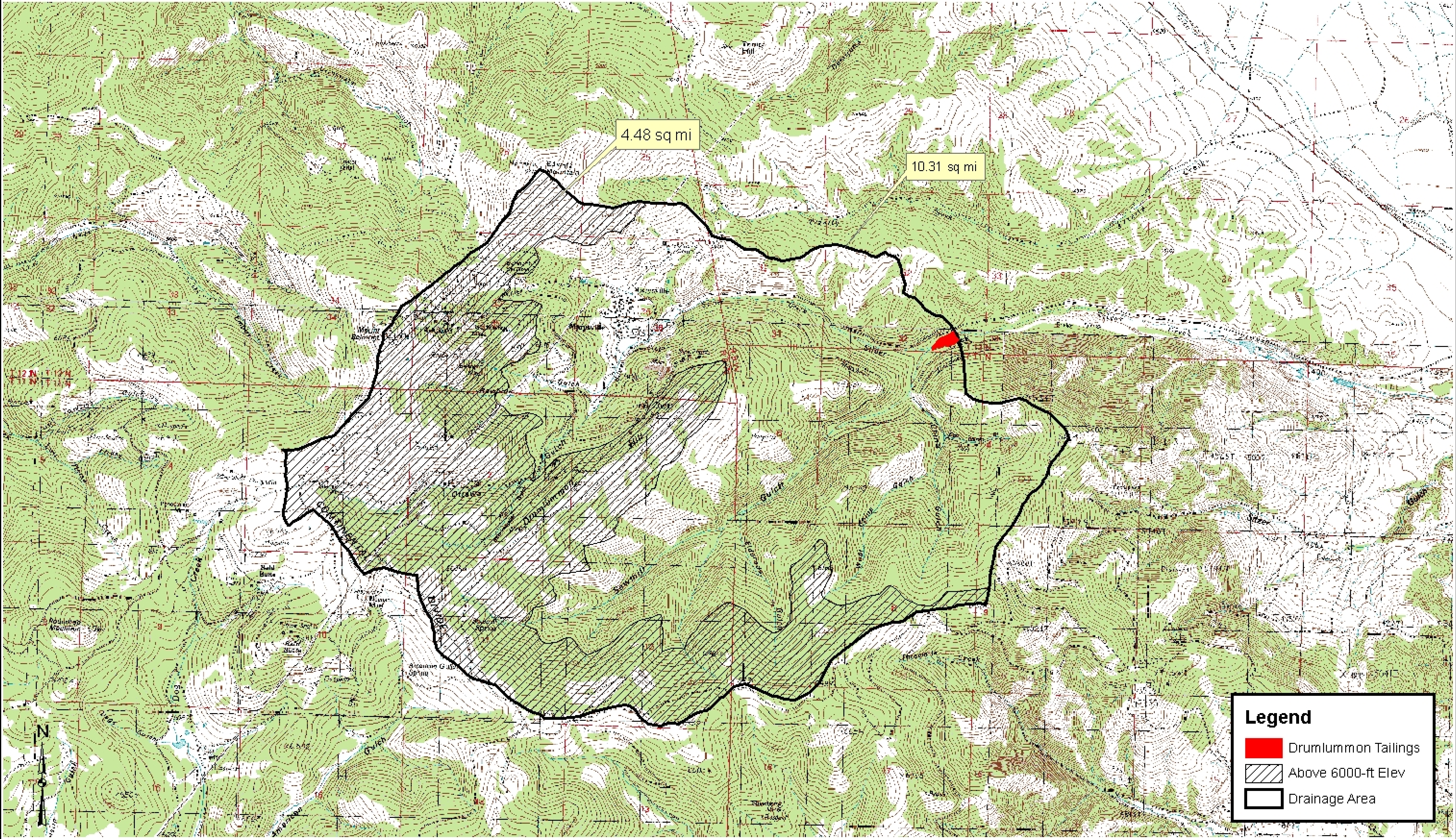
DRUMLUMMON TAILINGS AREA

FIGURE
3-2



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0 3,000 6,000
Feet

Figure 3-3
Drumlummon Tailings Drainage Basin Area

TABLE 3-2 ESTIMATES OF PEAK DISCHARGE FOR THE SILVER CREEK DRAINAGE ABOVE BIRDSEYE ROAD

Recurrence Interval (years)	Peak Discharge (cfs) by Regional Flood-Frequency Equations
2	40
5	89
10	141
25	227
50	302
100	391

3.2.2.2 Temporary Stream Diversion Design

As previously stated, Silver Creek flows through the Drumlummon tailings pile. Therefore, the removal action will involve construction of a temporary stream diversion to divert Silver Creek around the Drumlummon tailings to facilitate removal of the tailings. Test pits excavated in this area showed that the tailings are generally 1 to 3 feet thick, with a maximum thickness of approximately 5 feet in the vicinity of the tailings dam. Tailings will be excavated from along the northern perimeter of the Drumlummon tailings area to allow the construction of the temporary diversion. The bottom of the diversion channel will be excavated into native soil material so that no erosion of tailings is possible. The diversion channel has also been located to the north of the known tailings slime zone. The diversion channel location and details are shown on Figure 3-4.

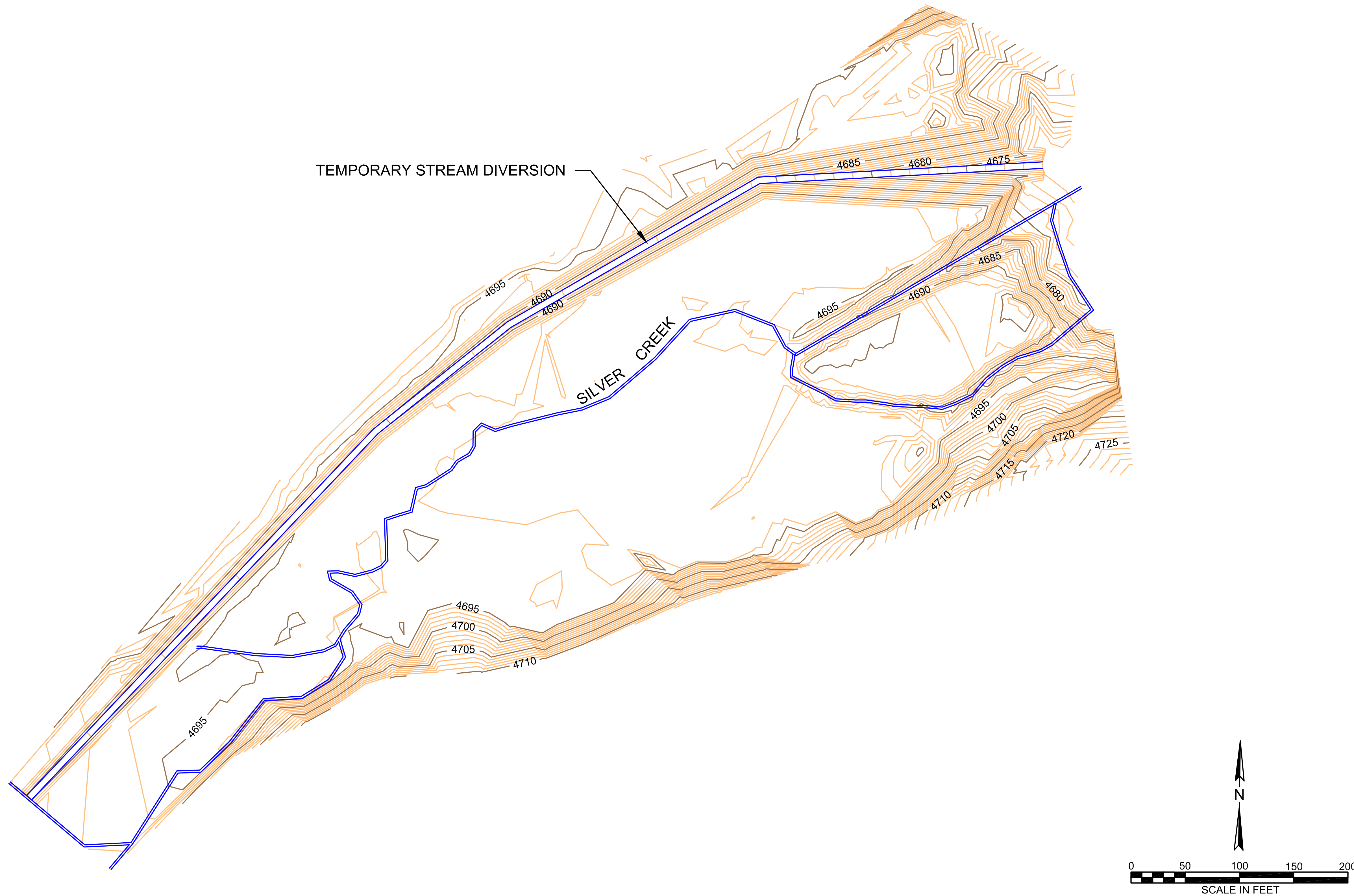
The earthwork required to construct the diversion channel includes the removal of 6,730 cubic yards of tailings and 1,960 cubic yards of underlying native soil to excavate the diversion channel subgrade. An additional 2,390 cubic yards of tailings are located to the north of the diversion channel, primarily in the dam area, and would be removed at the same time that the diversion channel is constructed. After Silver Creek is diverted into the diversion channel, the remaining tailings will be excavated and placed in the Goldsil repository.

The diversion channel will be constructed on a 1 percent slope through the main tailings pile area, and will steepen to approximately 5 percent through the tailings dam area. The diversion channel will be lined with coconut-fiber erosion control mat. The erosion control mat shall meet the following specifications:

Matrix .... 100% Coconut Fiber (0.50 lb/yd^2)

Netting........... Both sides, heavyweight UV stabilized (3.0 lbs/1,000 ft^2 approximate weight)

Thread........... 100% Black Polypropylene



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NO.	REVISION DESCRIPTION	BY	DATE	SCALE: AS SHOWN	FILENAME: A1416DTdiv.dwg			

DRUMLUMMON TAILINGS
TEMPORARY STREAM DIVERSION

FIGURE
3-4

3.2.2.3 Stream Reconstruction Design

Stream reconstruction design is commonly based on a reference reach in which stream properties are measured and then applied to the stream reconstruction area. The area immediately downstream from the Drumlummon tailings is braided and has a poorly defined channel because of the manner in which the channel is divided into two parallel segments through the Drumlummon tailings dam. Therefore, this segment was not considered applicable as a reference reach section. The area in the upper portion of the Drumlummon tailings is likely influenced by a backwater resulting from the artificially mild slope caused by the presence of the tailings pile and also by a series of small beaver dams. The confluence of Silver Creek and Sawmill Gulch is located a short distance upstream from the upper end of the Drumlummon tailings. These stream segments are not applicable as reference reaches because they each carry only a portion of the streamflow that flow through the Drumlummon tailings.

Therefore, a reference reach was selected that is directly upstream from the Drumlummon tailings, but downstream from the confluence of Silver Creek and Sawmill Gulch. This reach is rather short, but appears to be the most representative section of Silver Creek for the stream channel design. The channel cross section in a straight section of this reach was measured and is approximately trapezoidal in shape with a top that is seven feet wide, a depth of 1.5 feet and four feet wide across the bottom. The channel slope is approximately 2.4 percent in this section. The straight-line slope (i.e., floodplain slope) through the Drumlummon tailings area after the removal of the tailings is estimated at approximately 2.5 percent. Therefore, the application of this reference reach appears to be reasonable and appropriate.

The sinuosity of the existing stream channel through the Drumlummon tailings is approximately 1.25. Based on the measured stream properties, the stream through the Drumlummon tailings area meets the classification criteria of a Rosgen type G stream (Rosgen, 1996). These criteria include a low width/depth ratio (<12), moderate sinuosity (>1.2) and a slope range between 2 and 4 percent. Therefore, the stream reconstruction will be designed to correspond to a type G stream.

Bankfull discharge is the flow which fills a channel to the top of its banks and just begins to overflow onto the floodplain. Bankfull discharge typically occurs on the order of every 1.5 to 2 years. The reconstructed Silver Creek stream channel is designed to convey the bankfull discharge from the Silver Creek watershed. The floodplain is designed to convey discharges exceeding bankfull and has a capacity greater than the 100-year flood.

In order to design the channel, it was necessary to estimate the bankfull discharge of Silver Creek through the Drumlummon tailings. The bankfull discharge was estimated using two independent methods: 1) by field measurements and 2) by the recurrence interval. The bankfull discharge was estimated from reference reach cross sections. The stream slope through the reference reach is 2.4 percent. The discharge required to fill the measured cross section was calculated using a Manning n value of 0.050 for mountain streams with no vegetation in the channel, steep banks and cobbles (Chow, 1959). The discharge corresponding to a normal depth of 1.5 feet was calculated. Based on this calculation, the estimated bankfull discharge for Silver Creek is approximately 38 cfs.

The second method for estimating the bankfull discharge considers the typical recurrence interval at which bankfull occurs. Bankfull discharge is commonly estimated as the discharge with a recurrence interval in the range of 1.5 to 2 years. As shown in Table 3-2, the two year peak discharge estimated by USGS regional flood-frequency equations is 40 cfs. This compares well with the estimate of 38 cfs from the reference reach. Therefore, a bankfull discharge of 40 cfs was used for the stream reconstruction design.

The plan and profile views of the reconstructed stream channel through the Drumlummon tailings are shown on Figures 3-5 and 3-6, respectively. The stream channel geometry is shown on Figure 3-7. The slope of the reconstructed stream is 2.2 percent and the sinuosity is approximately 1.2. HEC-RAS was used to model water surface profiles of the reconstructed stream channel. The modeling shows that the stream is just starting to leave its banks in a few areas at a discharge of 40 cfs. This confirms that the bankfull discharge is approximately 40 cfs. The HEC-RAS modeling results are presented in Appendix B.

Stream channel construction includes excavation of the stream channel bottom and banks to the approximate lines and grades shown on the Figures 3-5 through 3-7, placement of streambed material, backfilling and grading to form the stream banks, placement of erosion control mat on the stream banks, and the installation of willow cuttings on the streambanks. The streambed will be lined with gravel and cobbles, while the stream banks will be lined with erosion control mat.

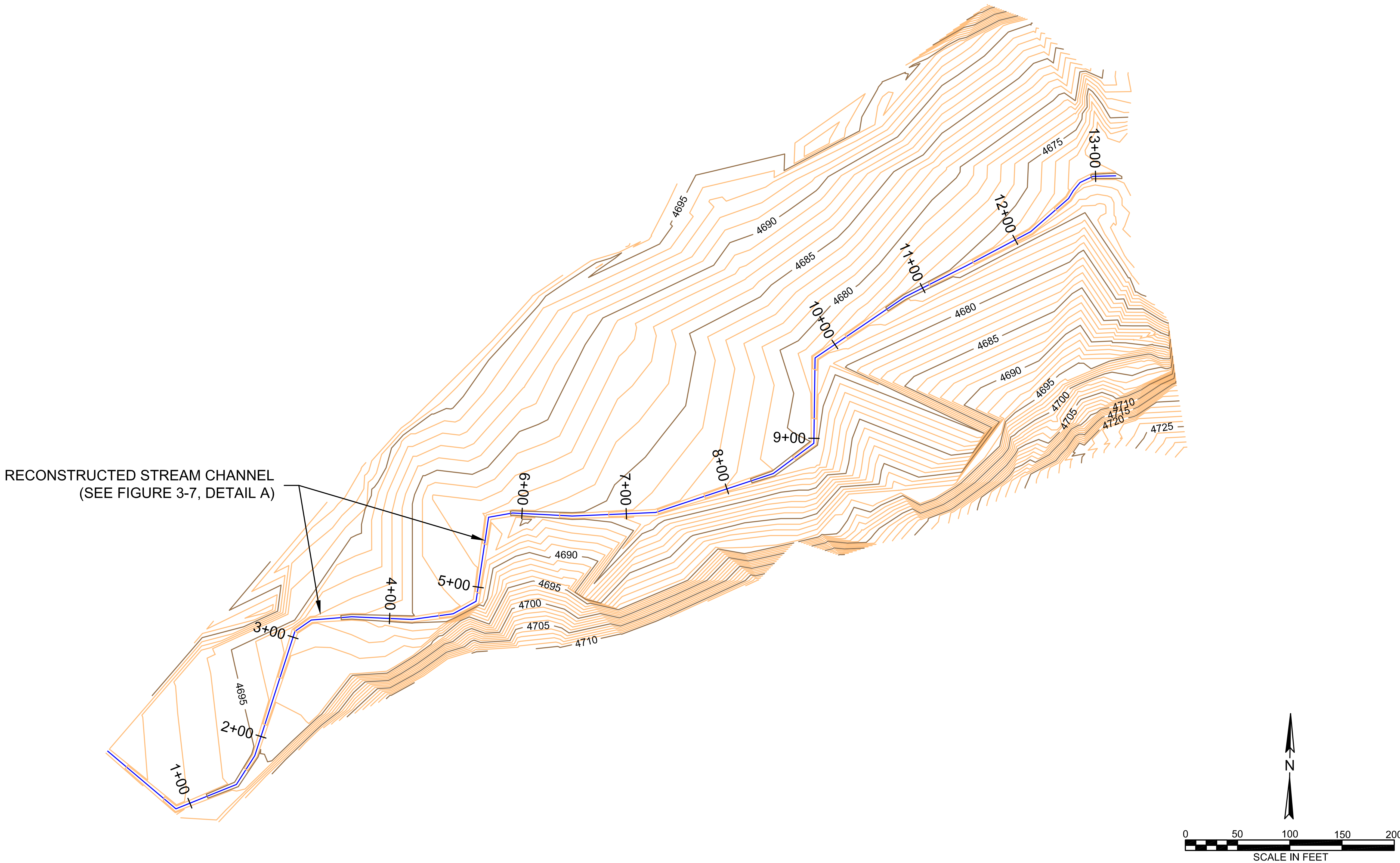
The coconut fiber channel lining shall be a machine-produced 100% biodegradable mat with a 100% coconut fiber matrix having a functional longevity of approximately 24 months. The blanket shall be of consistent thickness with the coconut fiber evenly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom sides with 100% biodegradable woven, natural, organic fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 0.50 x 1.00 inch mesh. The blanket shall be sewn together on 1.50 inch centers (50 stitches per roll width) with biodegradable thread. The blanket shall be manufactured with a colored line or thread stitched along both outer edges (approximately 2-5 inches from the edge) to ensure proper material overlapping. The coconut fiber channel lining shall have the following properties:

Material Content

Matrix......................... 100% Coconut Fiber (8 oz/sq. yd.)
Netting....................... Both sides, Leno woven 100% biodegradable organic jute fiber (9.30 lbs/1,000 ft^2 approximate weight)
Thread....................... Biodegradable

Physical Specifications (per roll)

Width......................... 6.67 ft ± 5%
Length....................... 108.00 ft ± 5%
Weight....................... 53.50 lbs ± 10%
Area.......................... 80 yd^2
Stitch Spacing........... 1.50 inches
Staples...................... The staple pattern shall be 3.8 staples per square yard, using staples produced from 11 gauge 0.118 to 0.120 bright basic industrial quality 1008/1010 wire, minimum cast, light oil protection. The staple dimensions shall be 6 inch x 1 inch in a U-shaped configuration.



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				APPROVED: KSR	DATE: 6/2004	JOB NO: A1416
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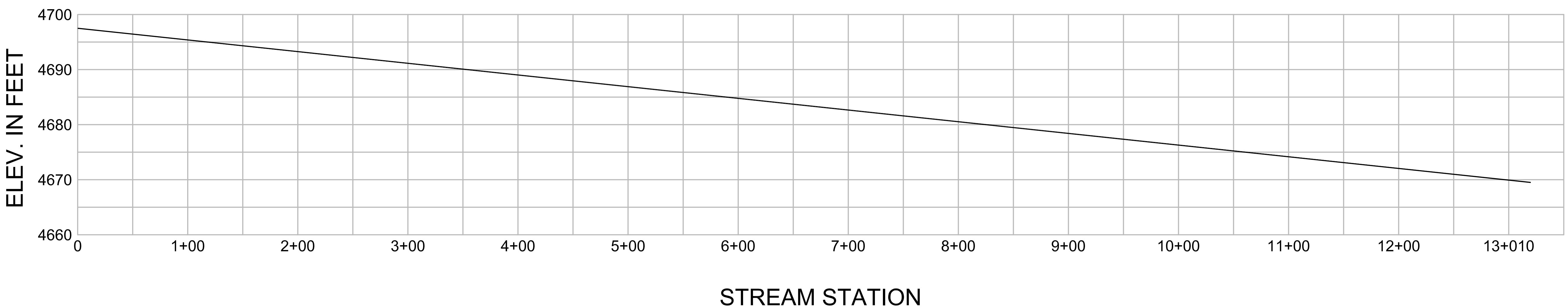
MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

DRUMLUMMON TAILINGS
FINAL GRADING AND
STREAM DESIGN

FIGURE
3-5



NOTE: SEE FIGURE 3-5 FOR STATION LOCATIONS

NO.	REVISION DESCRIPTION	BY	DATE	DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	RECONSTRUCTED SILVER CREEK STREAM PROFILE THROUGH THE DRUMLUMMON TAILINGS AREA	FIGURE 3-6
				APPROVED: KSR	DATE: 6-2004	JOB NO: A1416				
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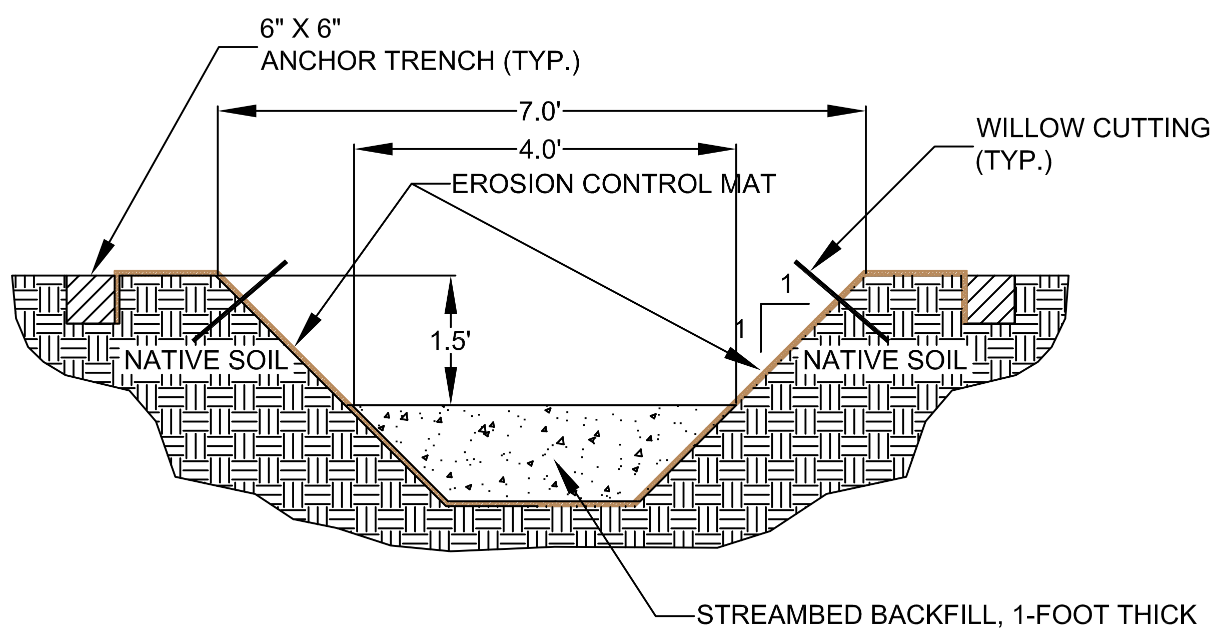
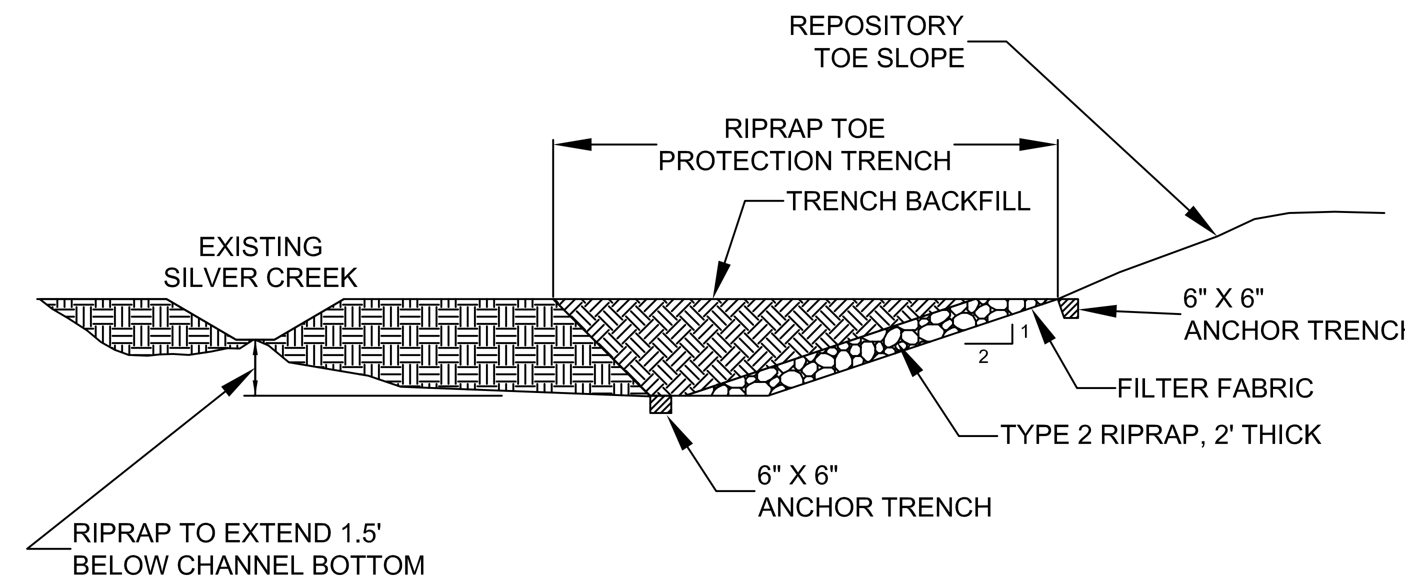


DETAIL A

TYPICAL STREAM CHANNEL CROSS

NOT TO SCALE



DETAIL B

TYPICAL RIPRAP SLOPE PROTECTION CROSS SECTION

NOT TO SCALE

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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

DRUMLUMMON TAILINGS STREAM CHANNEL AND REPOSITORY RIPRAP TOE PROTECTION DETAILS

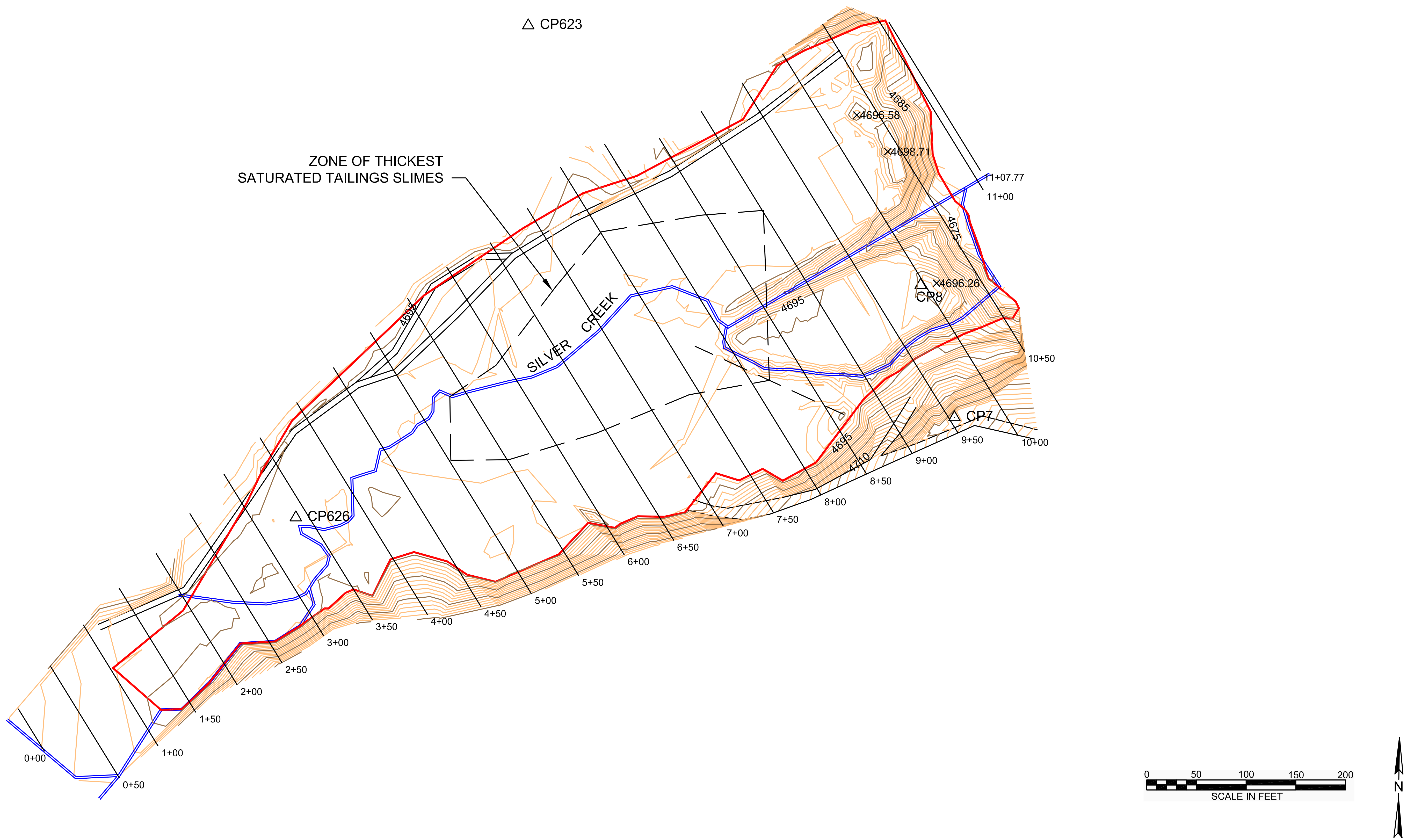
FIGURE 3-7

Streambed backfill material shall consist of on site gravels and cobbles excavated in the streambed area. Areas of the streambed excavation lacking in larger gravel and cobble material shall be supplemented with gravel and cobbles salvaged from the rock-lined stream channels through the Drumlummon tailings dam area. Additional gravel and cobble material is available from the Borrow Source No. 2 area (Figure 2-4), if necessary.

Willow cuttings will be installed on 2-foot centers along the reconstructed streambanks by driving them with shot-filled, rubber-coated mallets, through the erosion control mat. Installation of the willow cuttings shall satisfy the following specifications:

- All cuttings shall be taken from healthy, live stems of mature plants adapted to the climate of the project area.
- Cuttings shall comprise no more than 1/3 of any individual donor plant. Minimum cutting length shall be 18 inches; maximum length shall be 24 inches.
- All cuttings shall be greater than 0.5 inches in diameter at the narrowest portion of the cutting and shall be no greater than 1.25 inches at the widest portion of the cutting.
- The basal end (bottom) shall be indicated by a clean diagonal cut. All lateral stems shall be removed. Tops of cuttings shall be indicated by a cut perpendicular to the stem.
- If storage of cuttings for greater than one week is required, collected cuttings shall be divided into bundles of the same species and oriented with the basal ends all at the same end of the bundle. Bundles of cuttings should be tied with a non-degradable string in a manner that does not damage the stems, bark or other plant parts. Bundles shall be wrapped in wet burlap and kept cool, between 45°F and 65°F for up to 24 hours after collecting before being placed in cold storage. If stems are to be installed within one week, bundles can be kept in the open with the basal ends in open water.
- Willow cuttings shall be installed on 2-foot centers along the streambank by driving them with shot-filled, rubber-coated mallets through the erosion control mat. Fibers of the erosion control mat shall be spread prior to placement of the cuttings to prevent damage to the fabric.
- Protruding stems shall be the distal end, oriented downstream, with a length corresponding to that needed for the presence of three to four bud nodes. Mushroomed tops, from installation, must be clipped and coated with latex paint. Basal ends should be driven deep enough to be in contact with the normal low water surface.

The existing Drumlummon tailings topography and cross section locations are shown on Figure 3-8. Cross sections of the Drumlummon tailings area showing the existing and approximate post-reclamation surfaces, and the stream diversion are shown on Figures 3-9 through 3-12. The approximate post-reclamation topography of the Drumlummon tailings area stream reconstruction and floodplain areas is shown on Figure 3-5.



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				APPROVED:	DATE: 6/2004	JOB NO: A1416				
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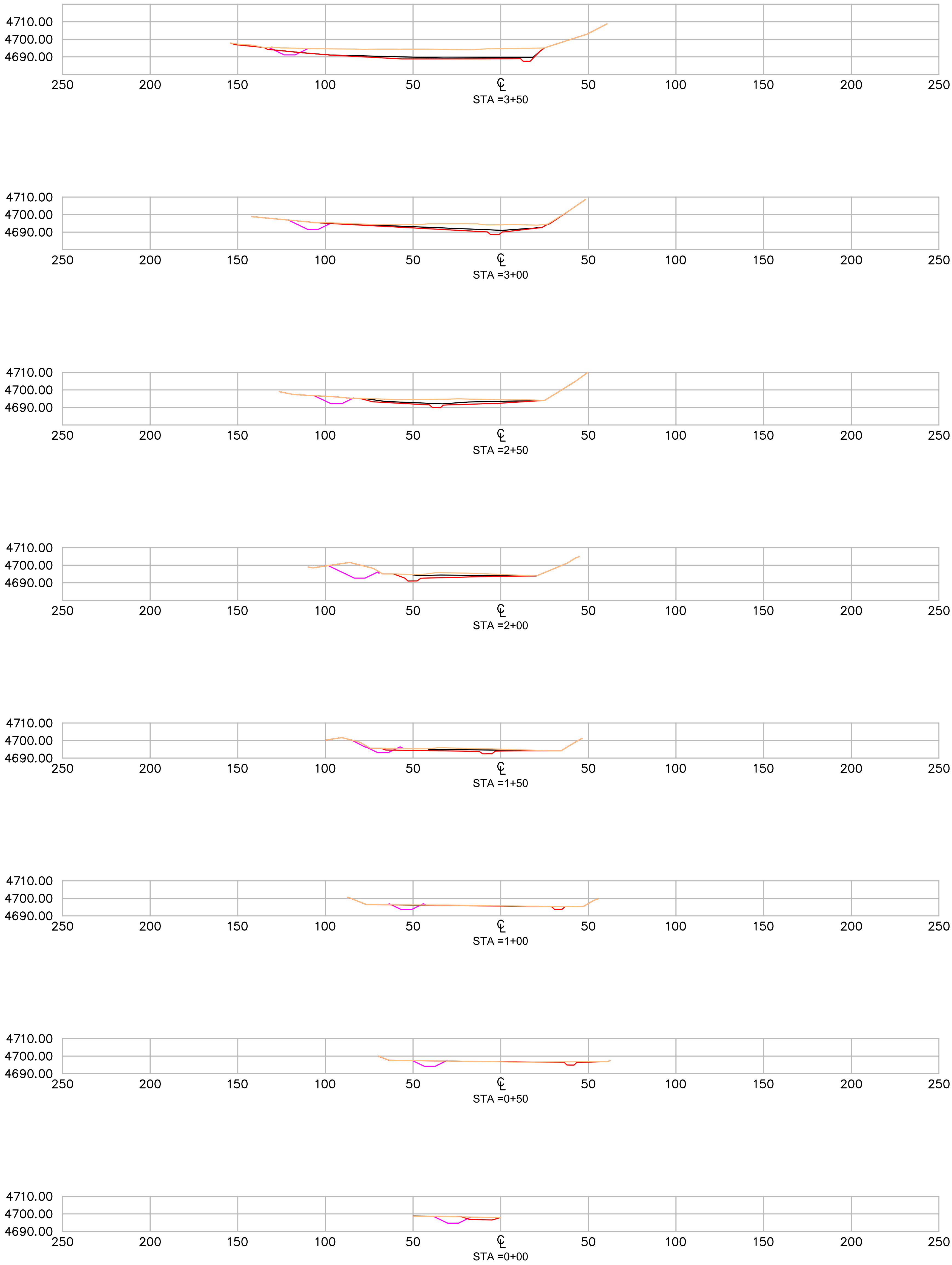

LEGEND

EXISTING SURFACE
NATIVE SURFACE
FINAL SURFACE
STREAM DIVERSION

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	DRUMLUMMON TAILINGS AREA CROSS SECTIONS STATION 0+00 - 3+50	FIGURE 3-9

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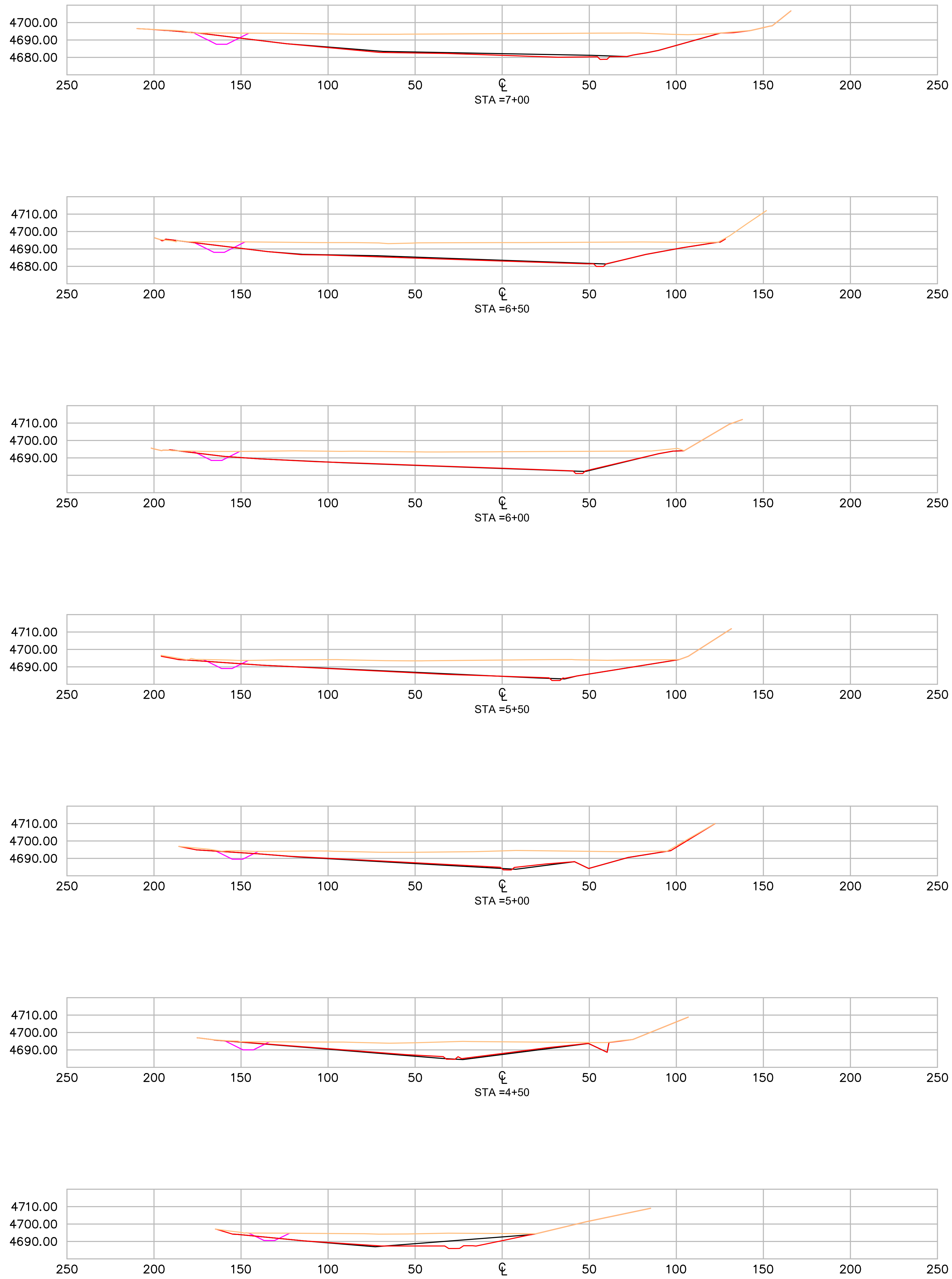

LEGEND

- EXISTING SURFACE
- NATIVE SURFACE
- FINAL SURFACE
- STREAM DIVERSION

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	DRUMLUMMON TAILINGS AREA CROSS SECTIONS STATIONS 4+00 - 7+00	FIGURE 3-10
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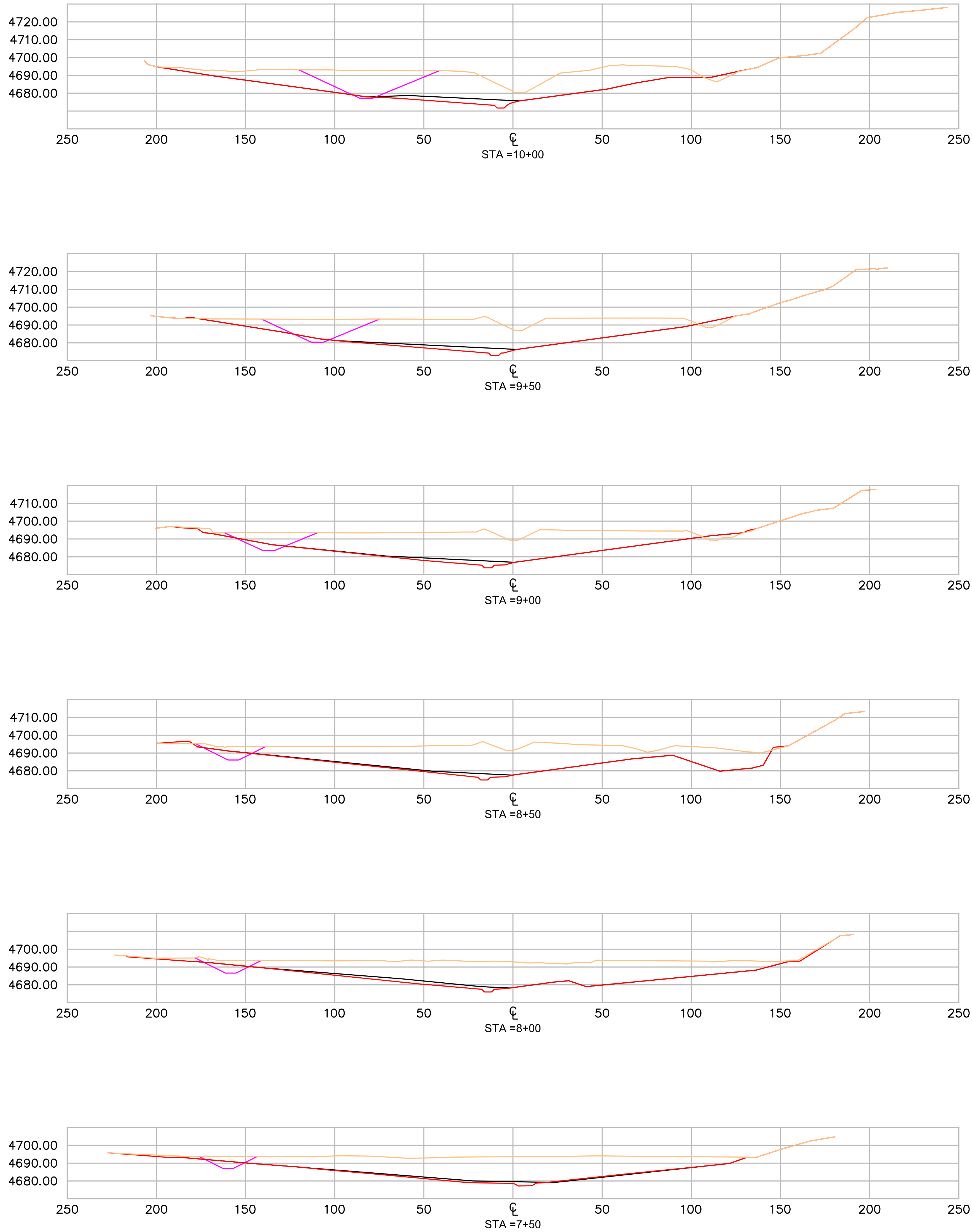

LEGEND

EXISTING SURFACE

NATIVE SURFACE

FINAL SURFACE

STREAM DIVERSION

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	DRUMLUMMON TAILINGS AREA CROSS SECTIONS STATIONS 7+50 - 10+00	FIGURE 3-11

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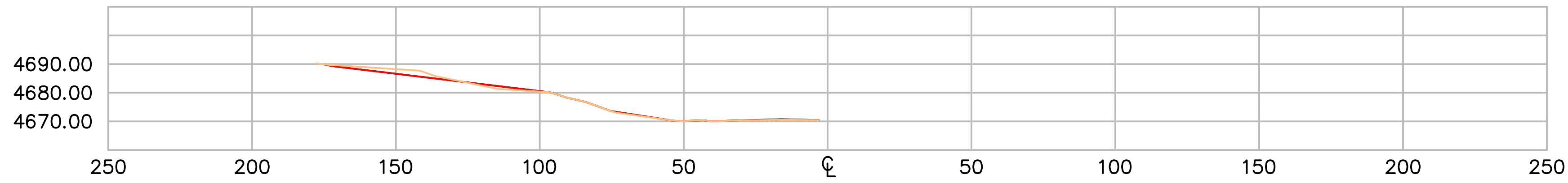

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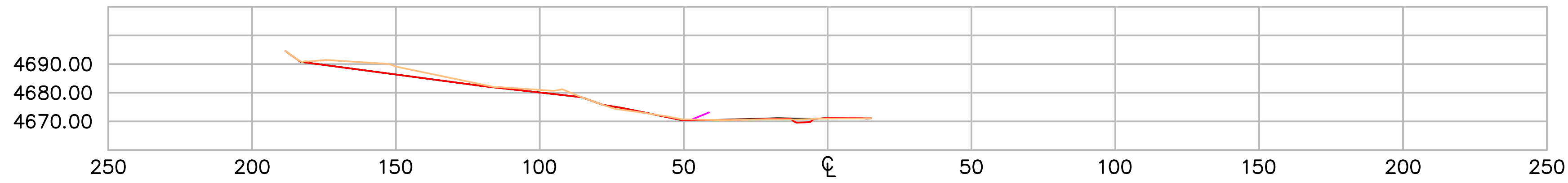

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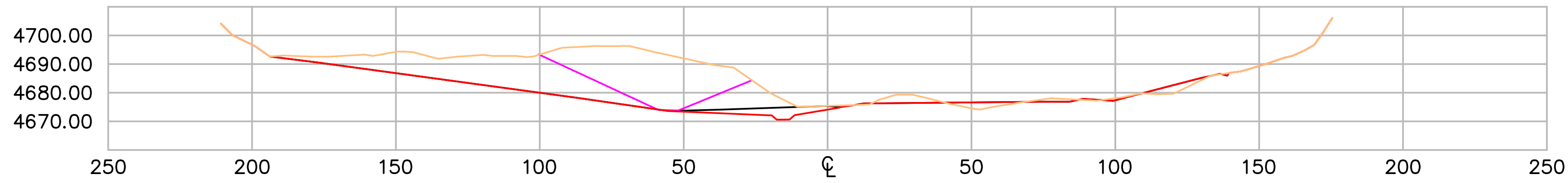

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LEGEND

- EXISTING SURFACE
- NATIVE SURFACE
- FINAL SURFACE
- STREAM DIVERSION

Olympus Technical Services, Inc.			MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA			DRUMLUMMON TAILINGS AREA CROSS SECTIONS STATIONS 10+50 - 11+07.77	FIGURE 3-12
DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416DTsec.dwg

3.2.3 Goldsil Tailings

An overview of the Goldsil millsite and tailings area is shown on Figure 3-13. Detailed maps of the Goldsil tailings area are shown on Figures 3-14 through 3-17. The Goldsil tailings area is comprised of the main Goldsil tailings, the lined pond area and the Goldsil millsite tailings. A total volume estimate for the mill tailings contained in the Goldsil tailings area is 491,970 cubic yards. The main Goldsil tailings range in thickness from less than 5 feet along the southern perimeter to greater than 40 feet in the north-central portion of the tailings. The ramp tailings in the Goldsil millsite area are up to 25 feet thick. The remaining tailings in the Goldsil area are generally less that 5 feet thick.

The reclamation plan for the Goldsil tailings area includes:

- removal of the main Goldsil tailings (458,430 cy), tailings within the lined pond east of the main Goldsil tailings (3,440 cy); the lined pond berm which appears to be a mixture of tailings and native soil (7,550 cy); tailings from the lined ditch from the lined pond that flows to a former pond north of the Goldsil mill area (660 cy); a lobe of tailings located north of the lined ditch (740 cy); tailings from the Goldsil mill vat tank area (1,200 cy); tailings from the ramp west of the Goldsil mill (19,870 cy); and tailings in the tank bottoms within the Goldsil mill foundation (80 cy).

- removal and disposal of debris from the two boneyard areas between the lined pond and the Goldsil mill;

- removal and disposal of a solid waste pit north of the Goldsil mill area;

- removal and disposal of the tank bottoms, the ball mill and ball mill foundation, a concrete retaining and a wood crib wall in the Goldsil mill area;

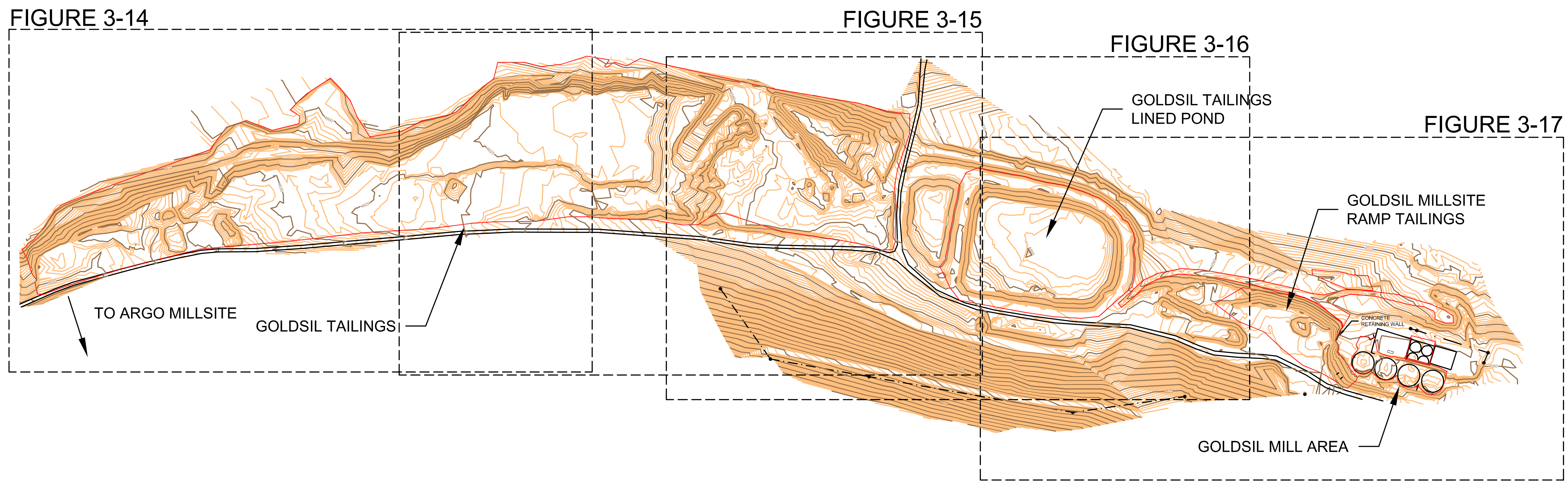
- recovery and stockpiling of native soil material from the ramp stockpile between the lined pond and the Goldsil mill for use as cover soil; and

- placement and grading of mill tailings in the repository.

There are an estimated 469,420 cubic yards of tailings in the Goldsil tailings area and 22,550 cubic yards in the Goldsil millsite area (491,970 cubic yards total). These tailings will be excavated and relocated in the Goldsil repository. The lined pond area and the eastern portion of the main Goldsil tailings are within the repository footprint and will be excavated and removed prior to preparation of the repository base (Section 3.5.1).

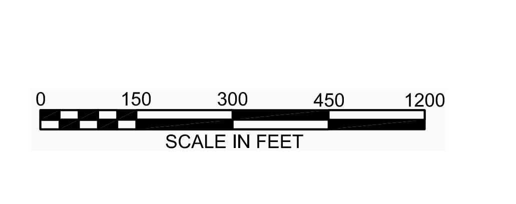
The ramp area between the lined pond and the Goldsil mill contains an estimated 4,750 cubic yards of native fill. This fill can be salvaged and used as fill for grading waste source areas or as cover soil for the repository. Debris from a boneyard area must be removed prior to salvaging the fill material. Debris from the boneyard and other debris areas in the Goldsil area will be disposed of as outlined in Section 3.3.

The existing Goldsil tailings topography and cross section locations are shown on Figure 3-18. Cross sections of the Goldsil tailings area, showing both the existing and approximate post-reclamation surfaces are shown on Figures 3-19 through 3-27. The approximate post-reclamation topography of the Goldsil tailings and repository area are shown on Figure 3-28.



LEGEND

TAILINGS BOUNDARY



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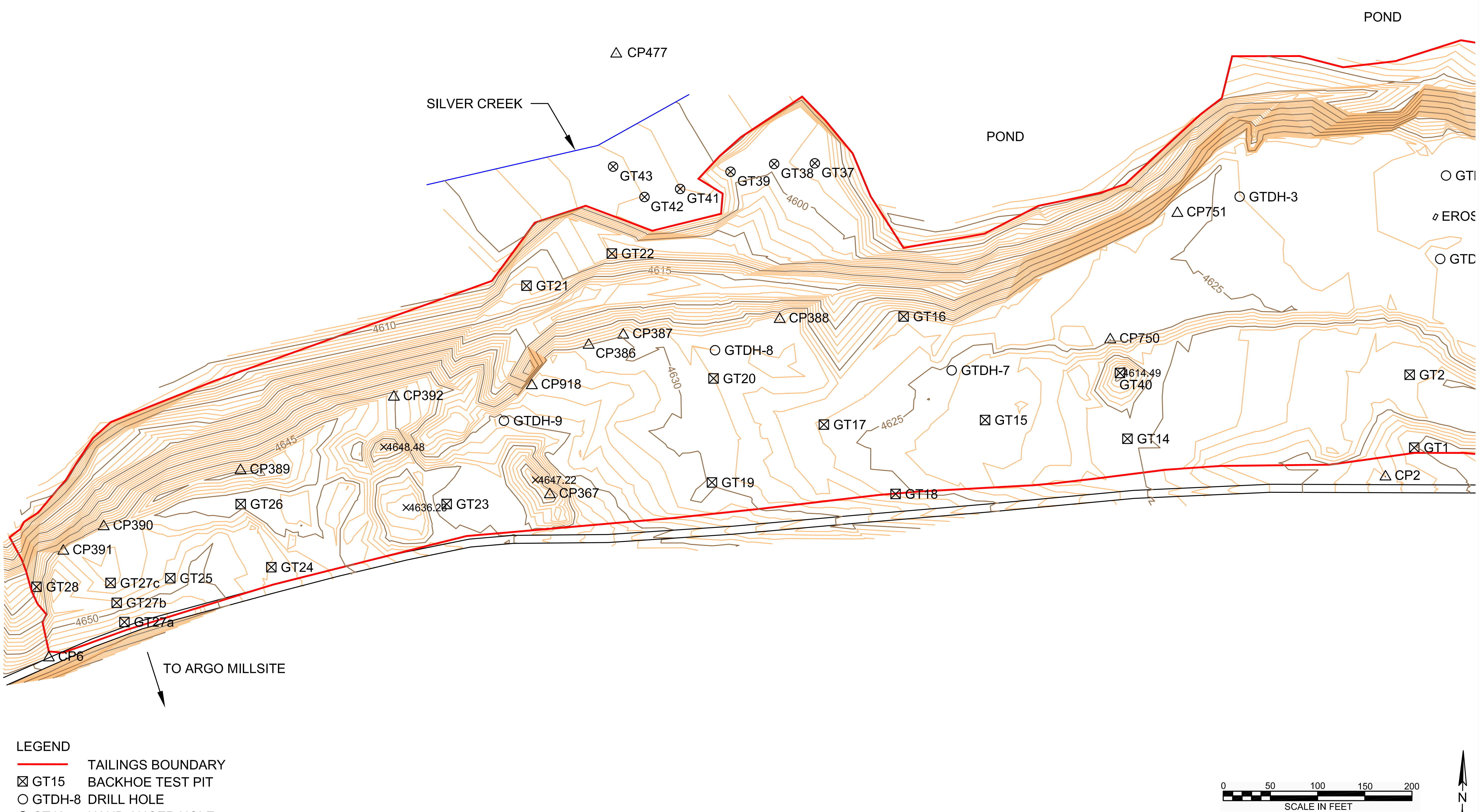
				APPROVED:	DATE: 6-2004	JOB NO: A1416				
				SCALE: AS SHOWN	FILENAME: A1416GTplan.dwg					



LEGEND

(red line)	TAILINGS BOUNDARY
GT15	BACKHOE TEST PIT
GTDH-8	DRILL HOLE
GT43	HAND AUGER HOLE
CP2	SURVEY CONTROL POINT

NO.	REVISION DESCRIPTION	BY	DATE

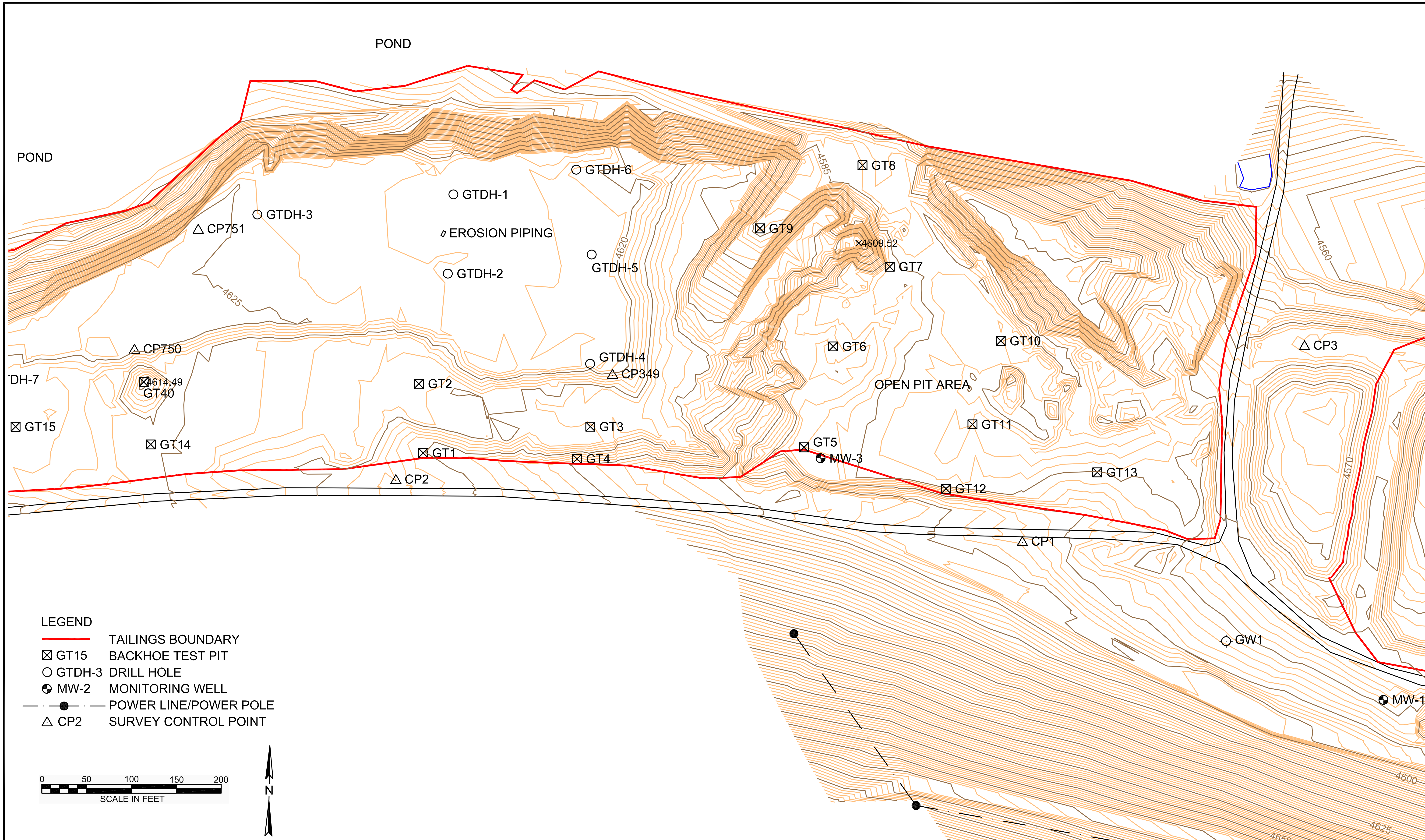
DESIGN:	DRAWN: KSR	CHECKED: CRS
APPROVED:	DATE: 6/2004	JOB NO: A1416
SCALE: AS SHOWN	FILENAME: A1416GTplan.dwg	

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

WEST END OF GOLDSIL TAILINGS

FIGURE
3-14



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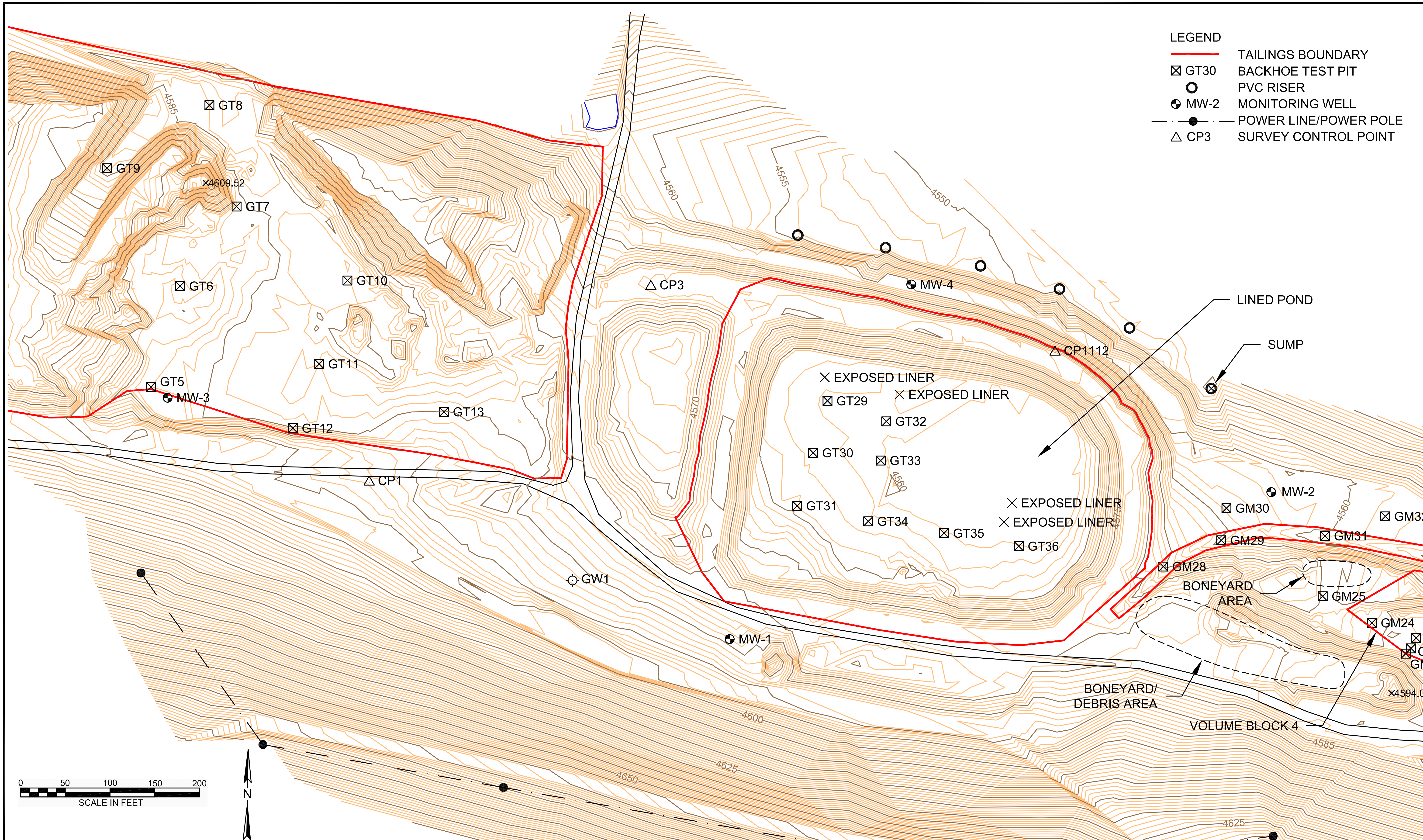
			APPROVED:	DATE: 6/2004	JOB NO: A1416		CENTRAL PORTION OF GOLDSIL TAILINGS
NO.	REVISION DESCRIPTION	BY / DATE	SCALE: AS SHOWN	FILENAME: A1416GTplan.dwg			FIGURE 3-15



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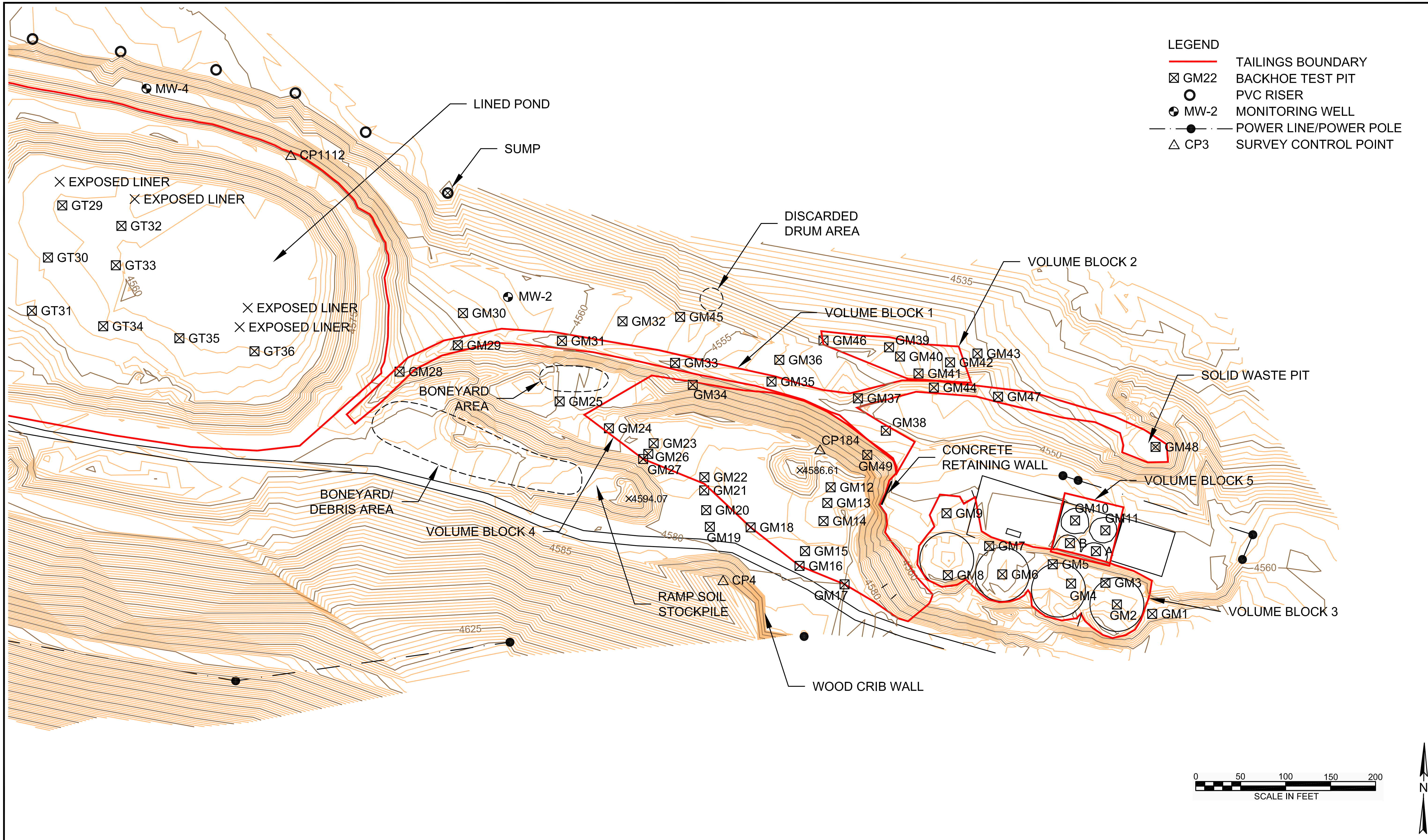
MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

GOLDSIL MILLSITE
LINED TAILINGS IMPOUNDMENT

FIGURE
3-16



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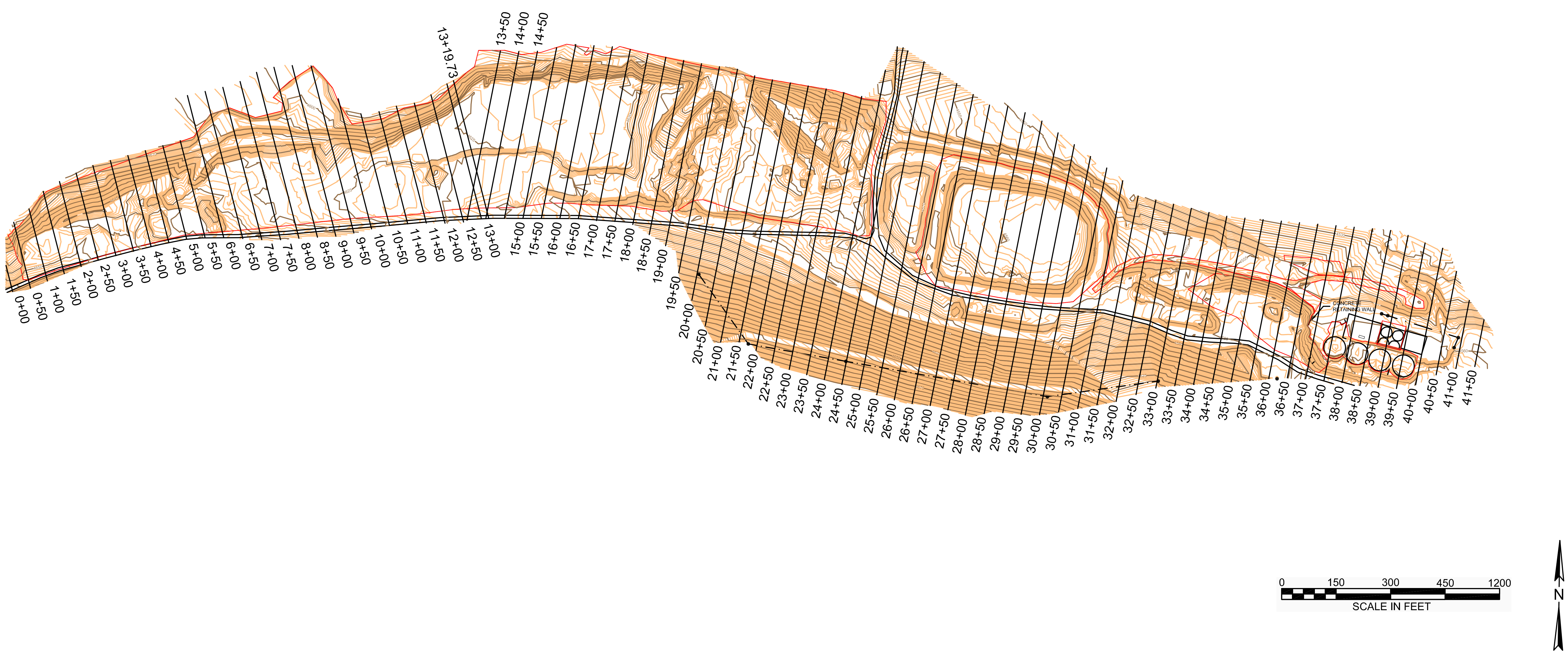
MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

GOLDSIL MILLSITE AREA

FIGURE 3-17



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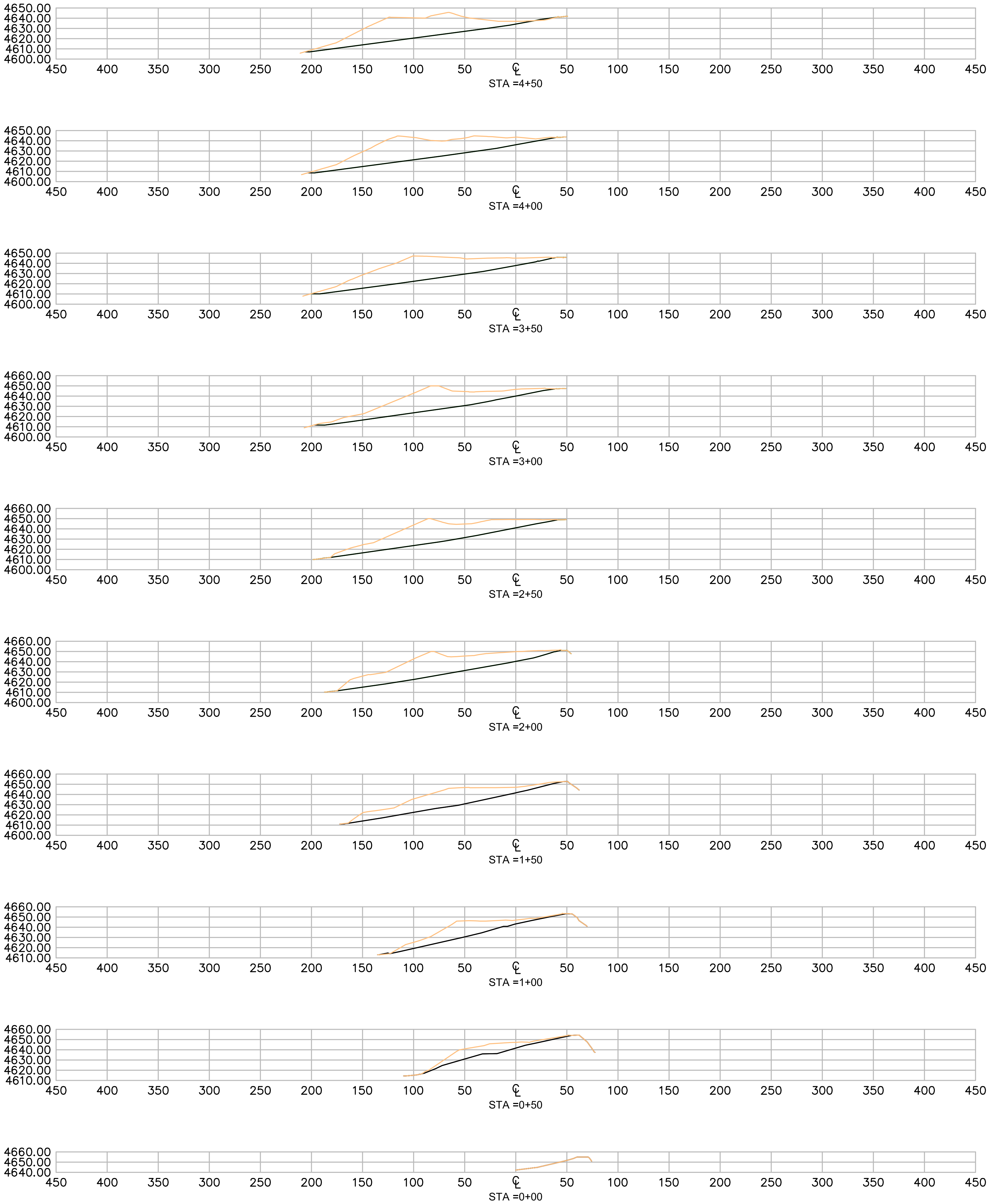

LEGEND

EXISTING SURFACE
NATIVE SURFACE
REPOSITORY
REPOSITORY BASE

Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

GOLDSIL TAILINGS AREA
CROSS SECTIONS
STATION 0+00 - 4+50

FIGURE 3-19

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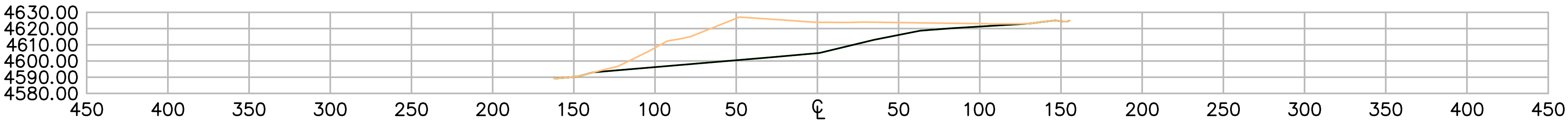

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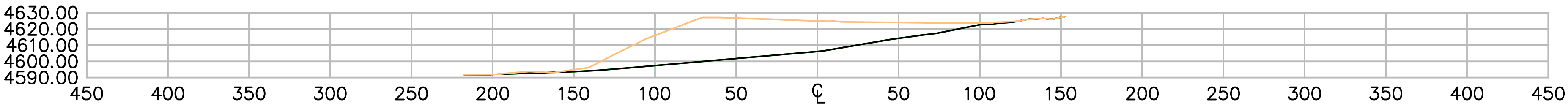

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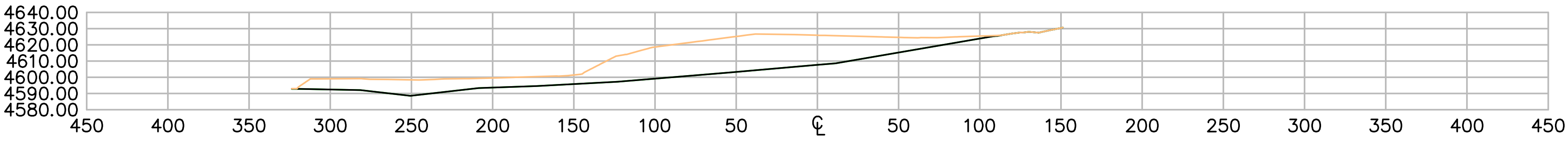

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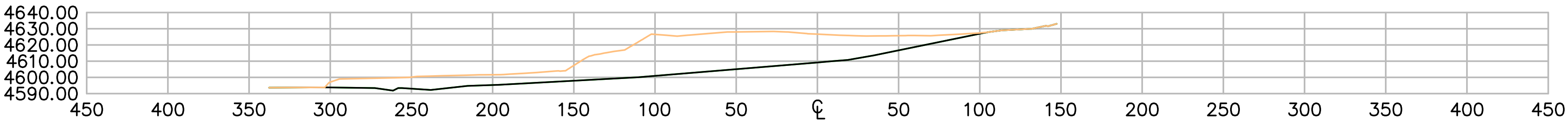

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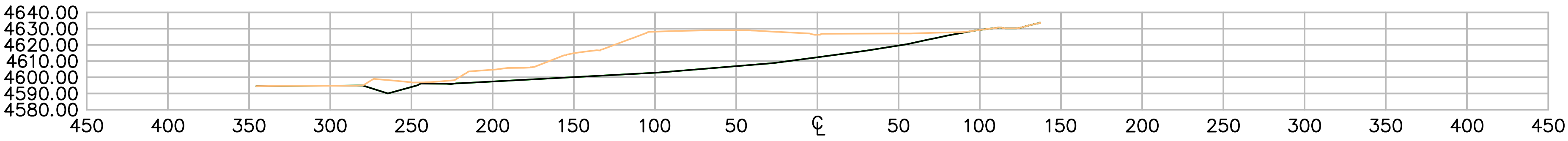

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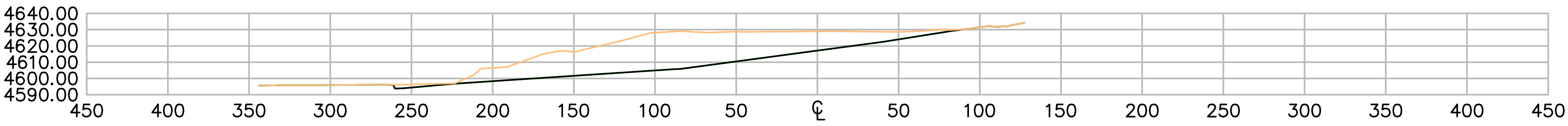

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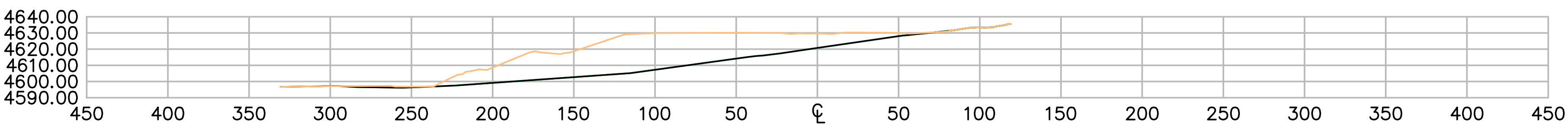

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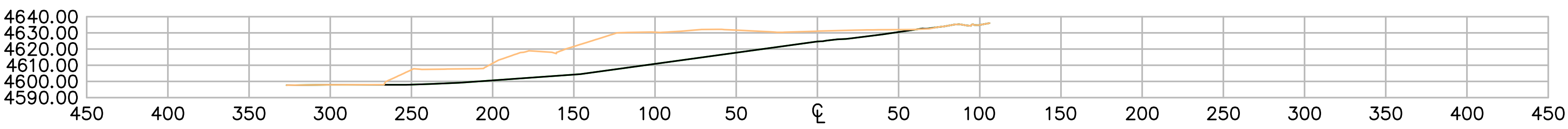

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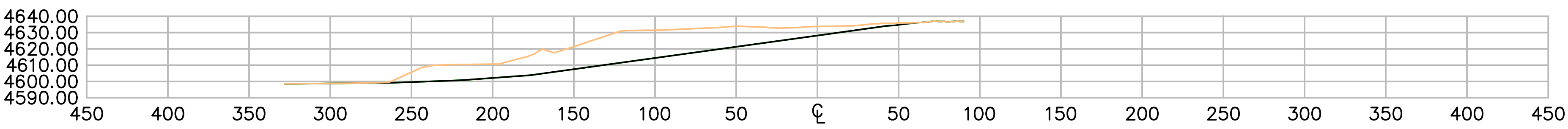

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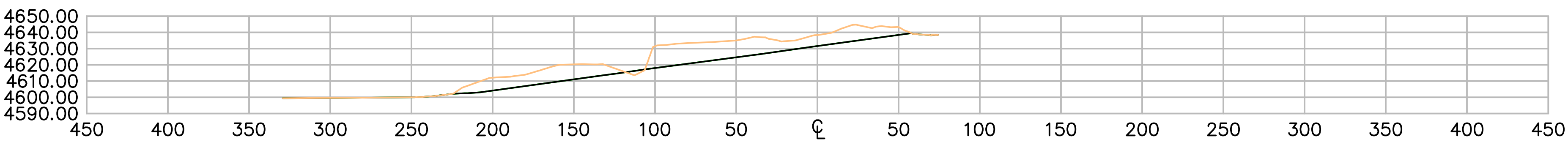

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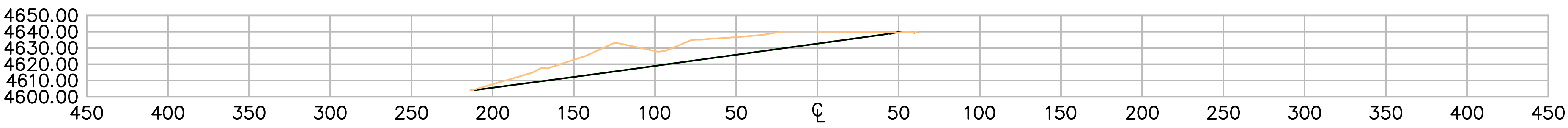

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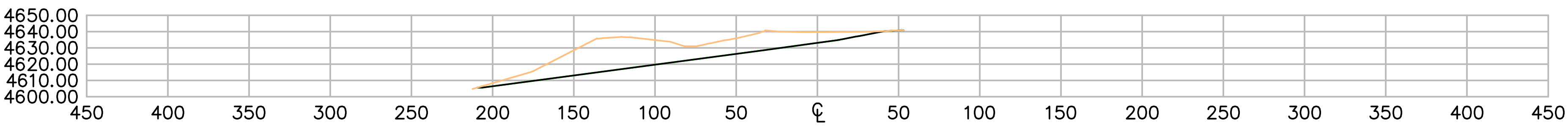

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SEE LEGEND ON FIGURE 3-19

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	GOLDSIL TAILINGS AREA CROSS SECTIONS STATION 5+00 - 10+50	FIGURE 3-20

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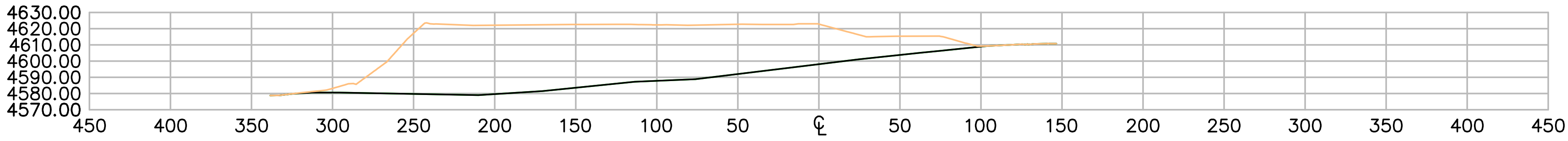

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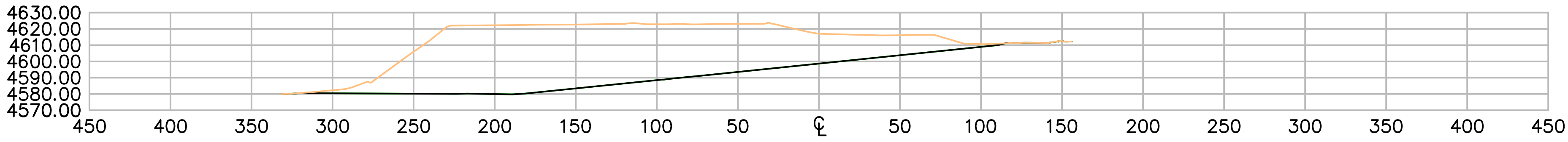

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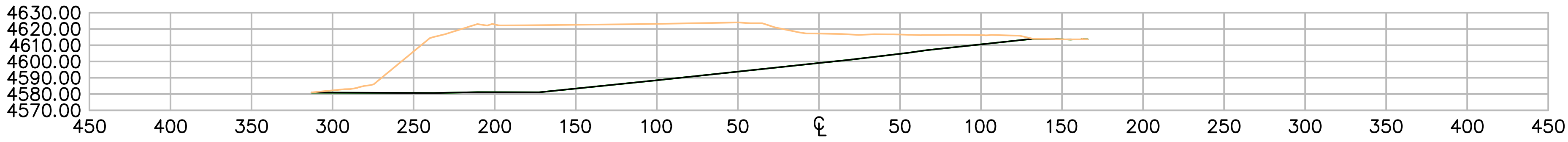

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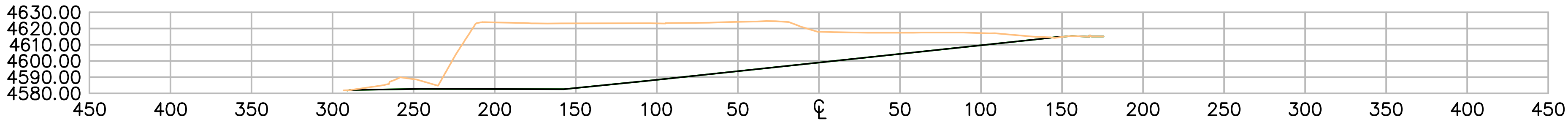

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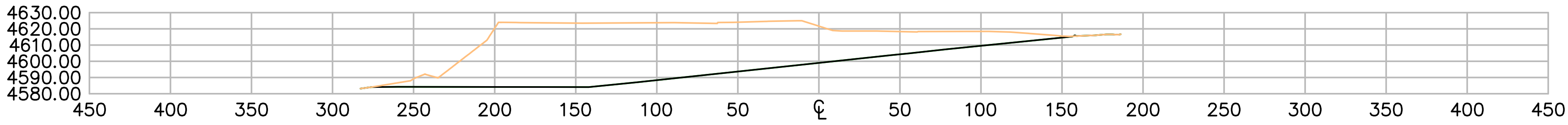

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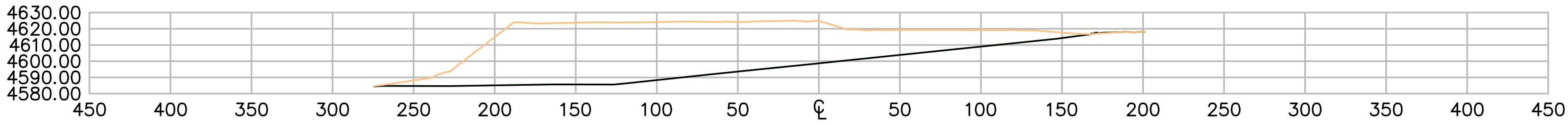

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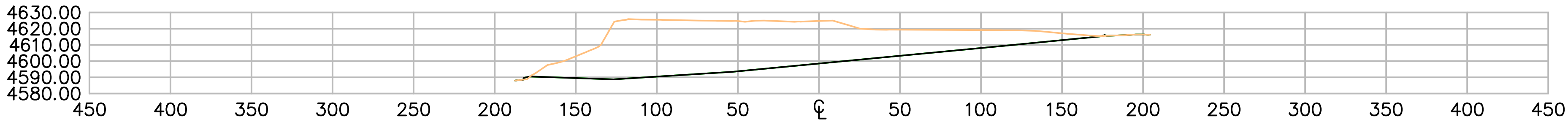

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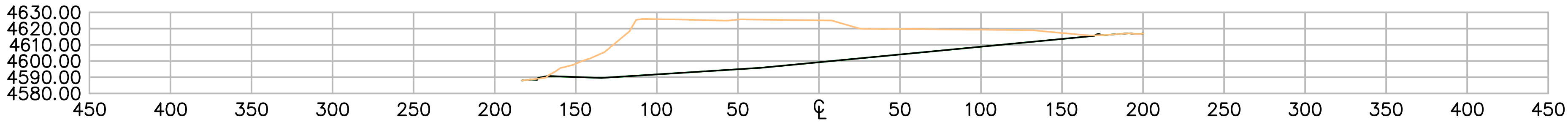

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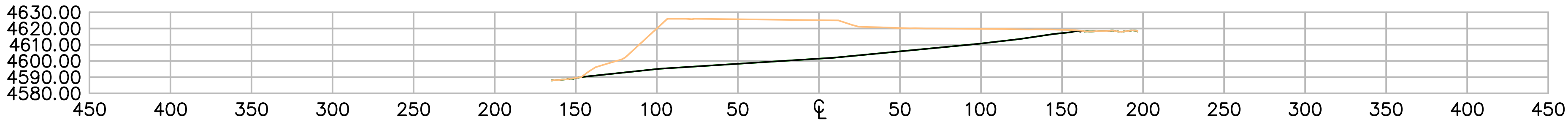

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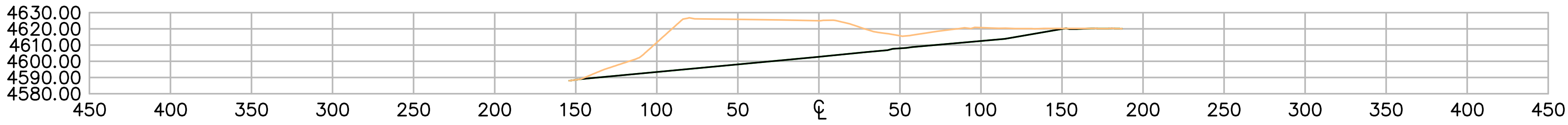

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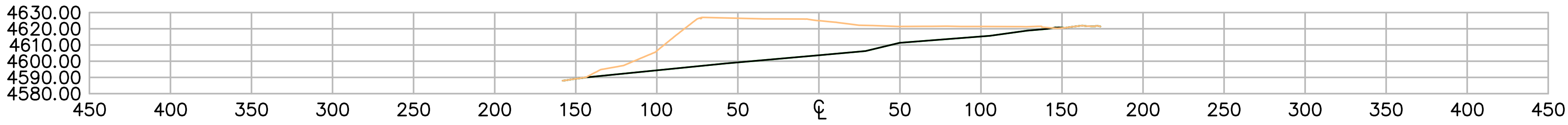

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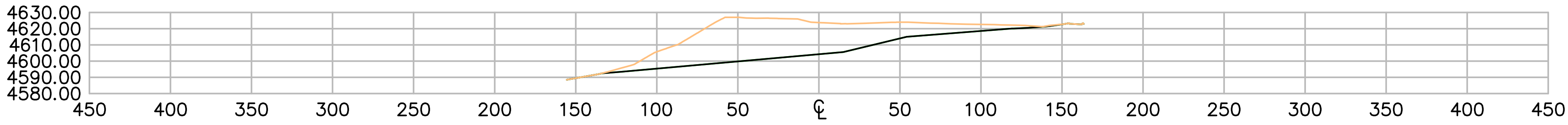


STA =11+00

SEE LEGEND ON FIGURE 3-19

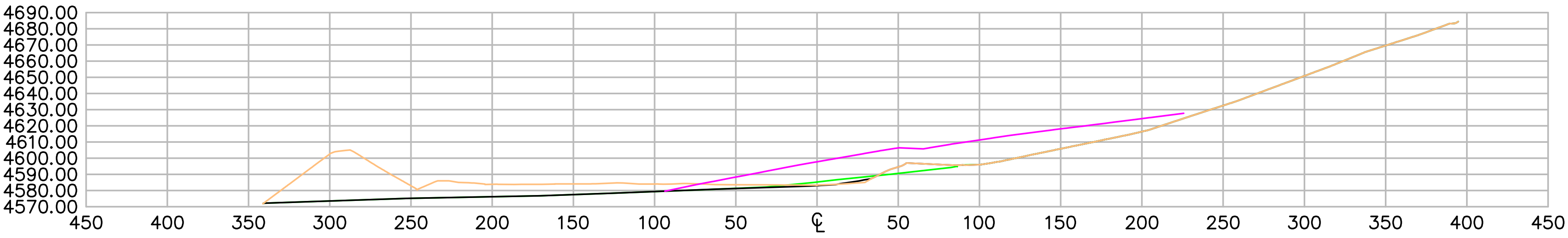
Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

GOLDSIL TAILINGS AREA
CROSS SECTIONS
STATION 11+00 - 16+00

FIGURE
3-21

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416GTsec.dwg



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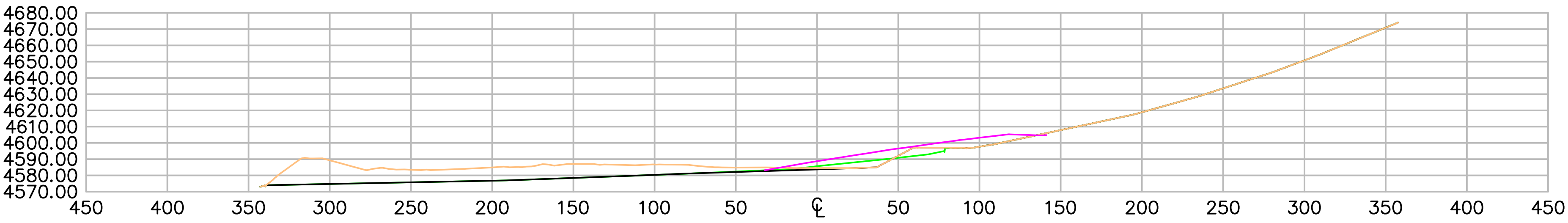

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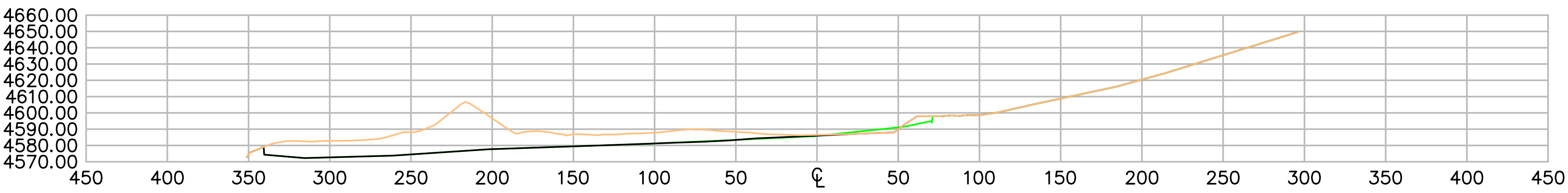

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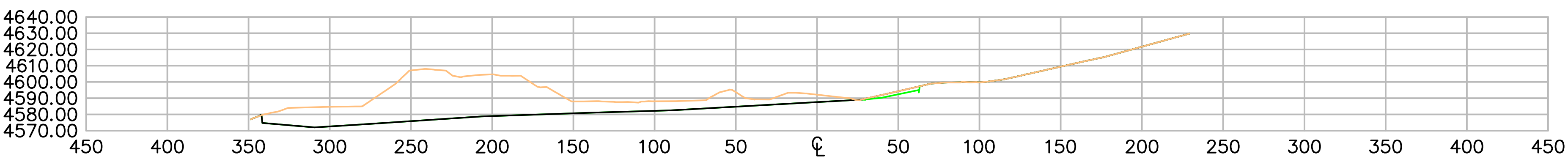

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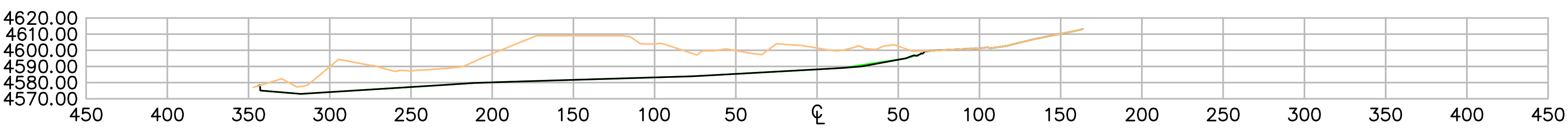

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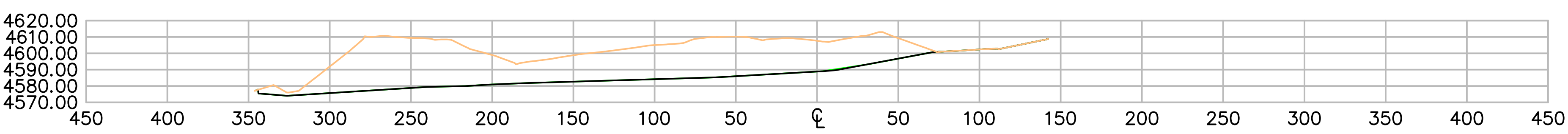

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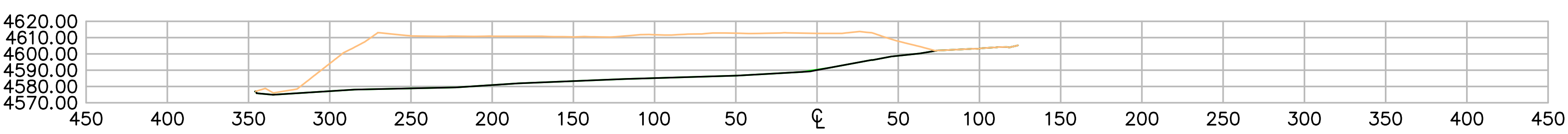

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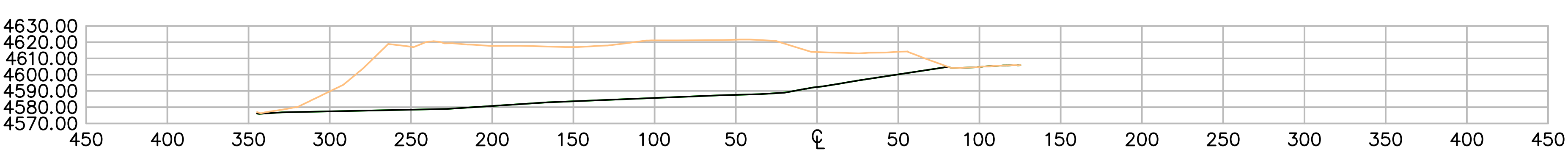

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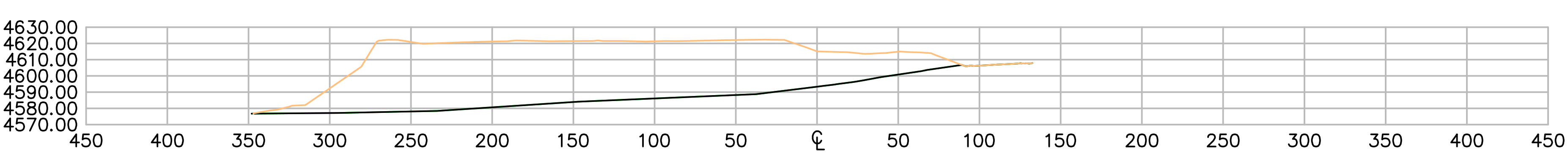

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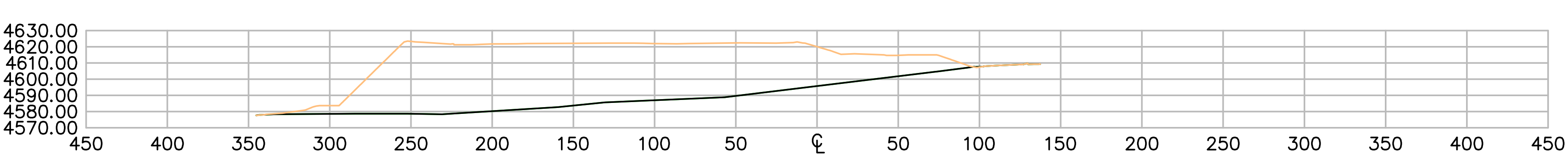

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SEE LEGEND ON FIGURE 3-19

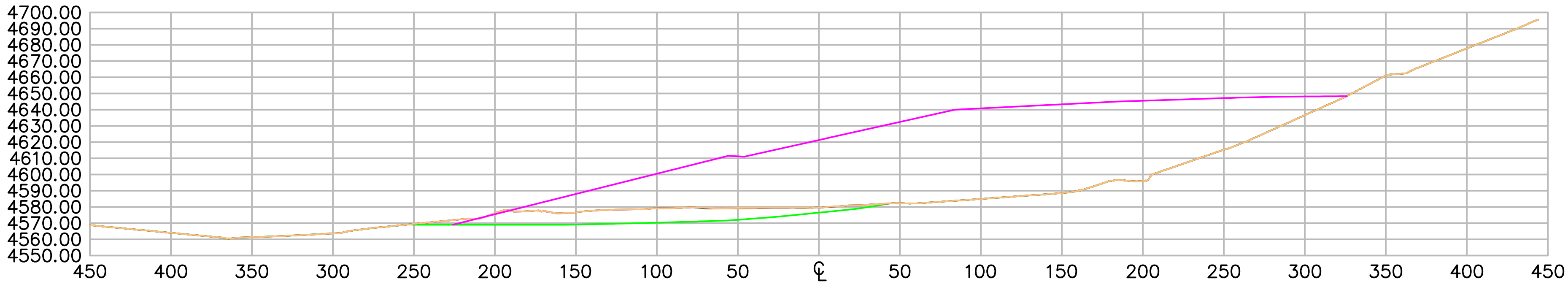
Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

GOLDSIL TAILINGS AREA
CROSS SECTIONS
STATION 16+50 - 21+00

FIGURE
3-22

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416GTsec.dwg



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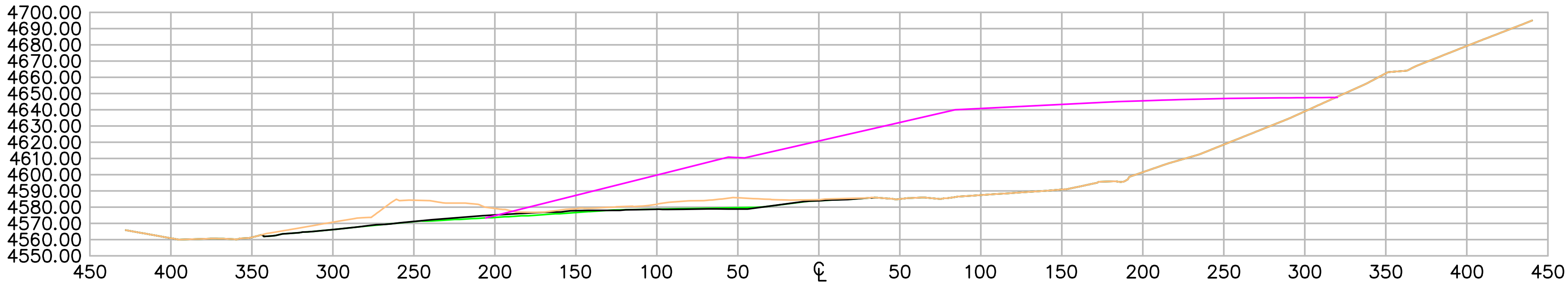

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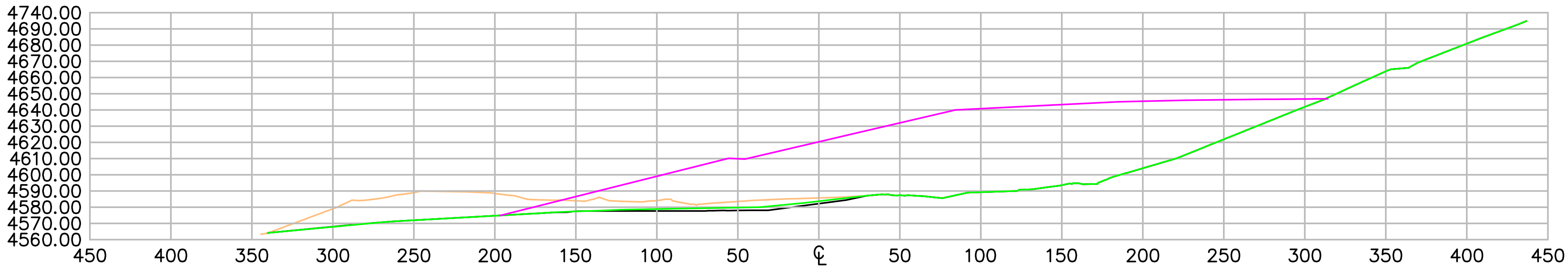

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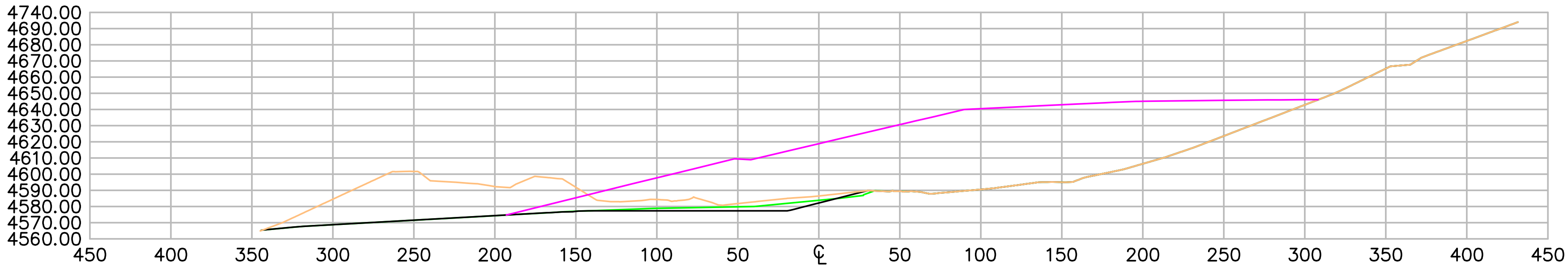

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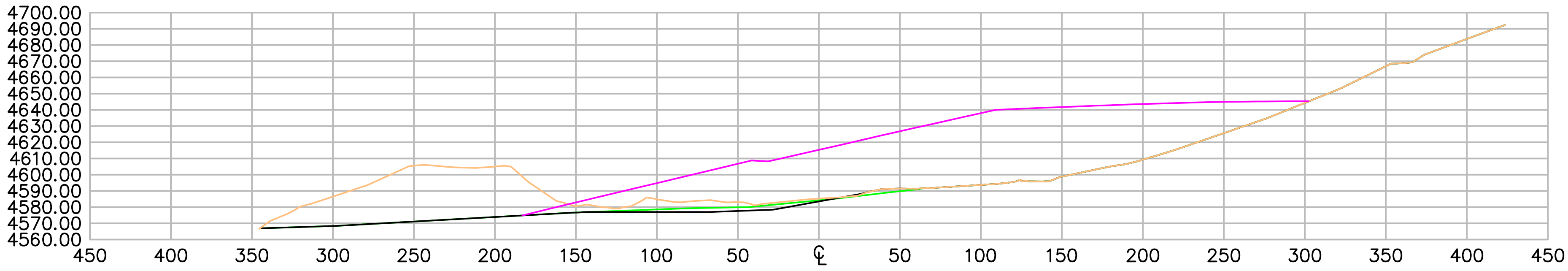

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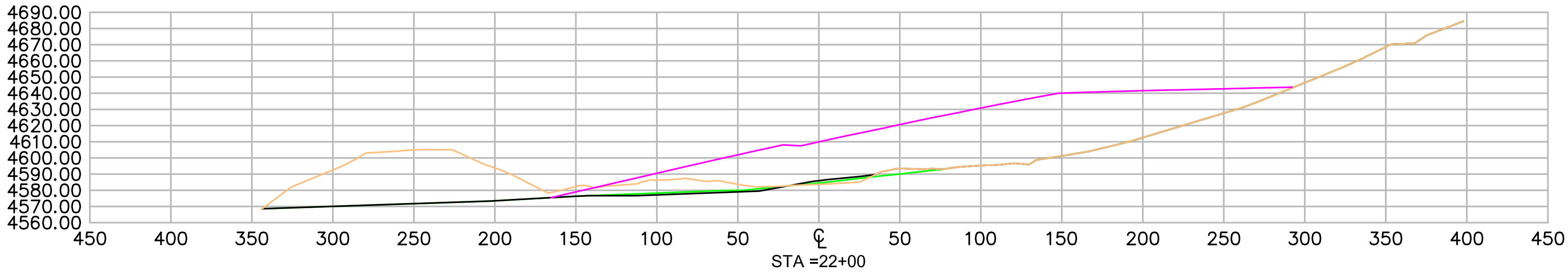

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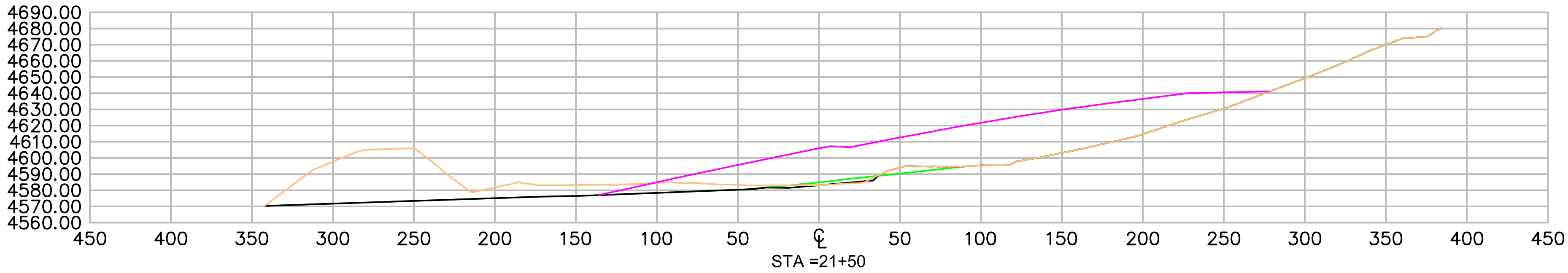

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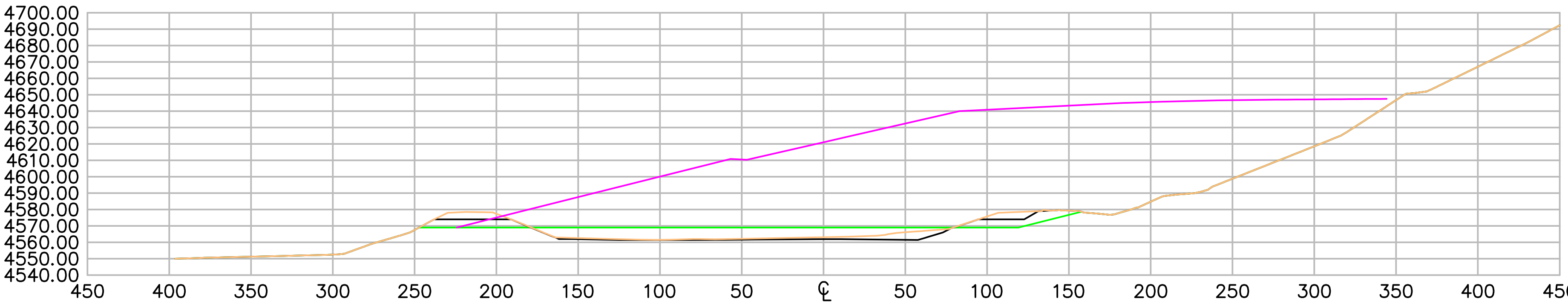
SEE LEGEND ON FIGURE 3-19

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	GOLDSIL TAILINGS AREA CROSS SECTIONS STATION 21+50 - 24+50	FIGURE 3-23

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416GTsec.dwg



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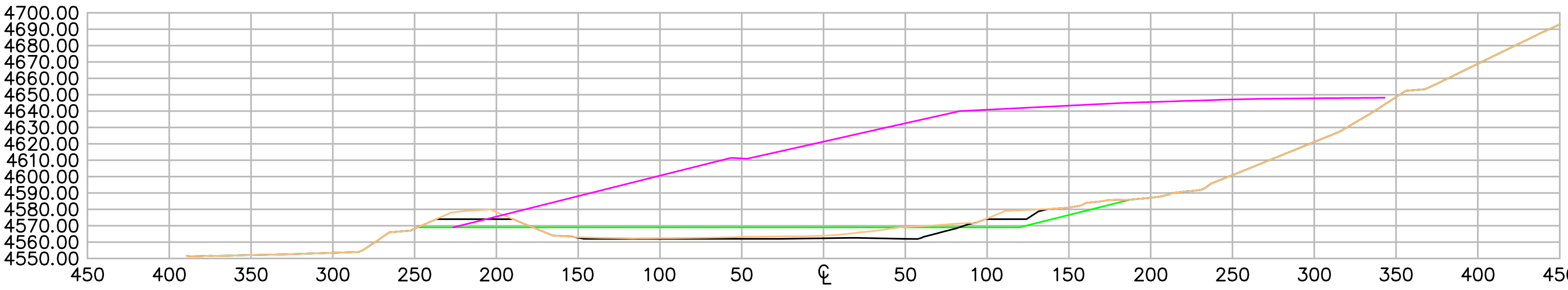

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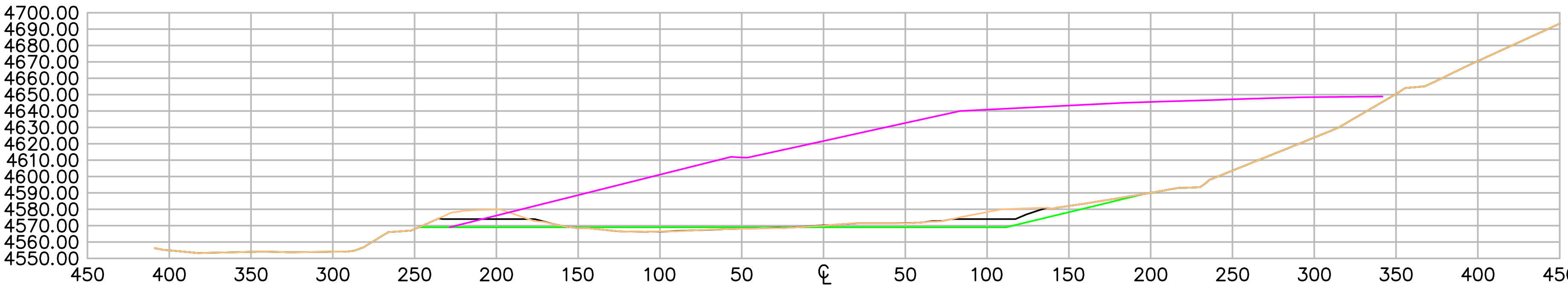

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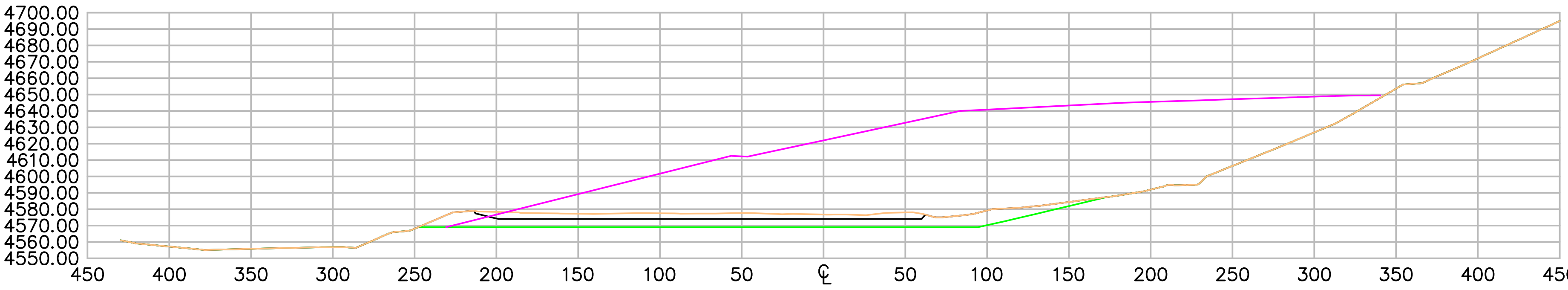

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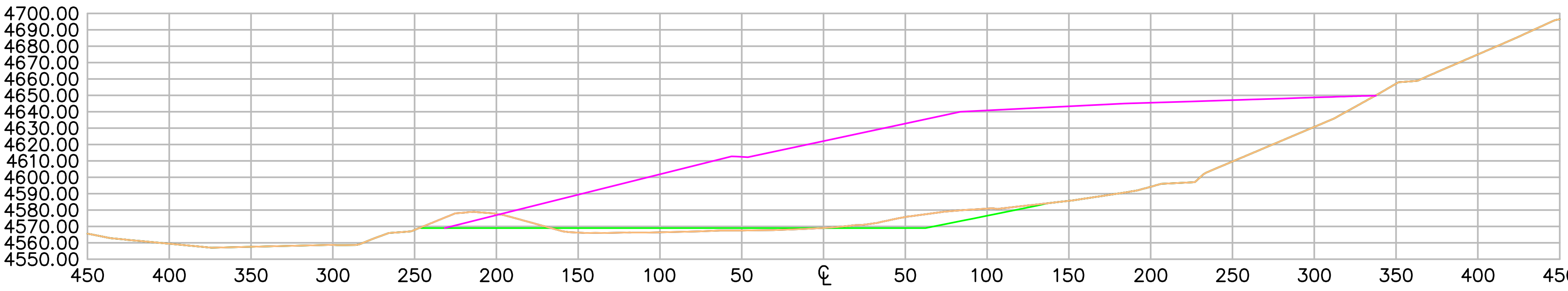

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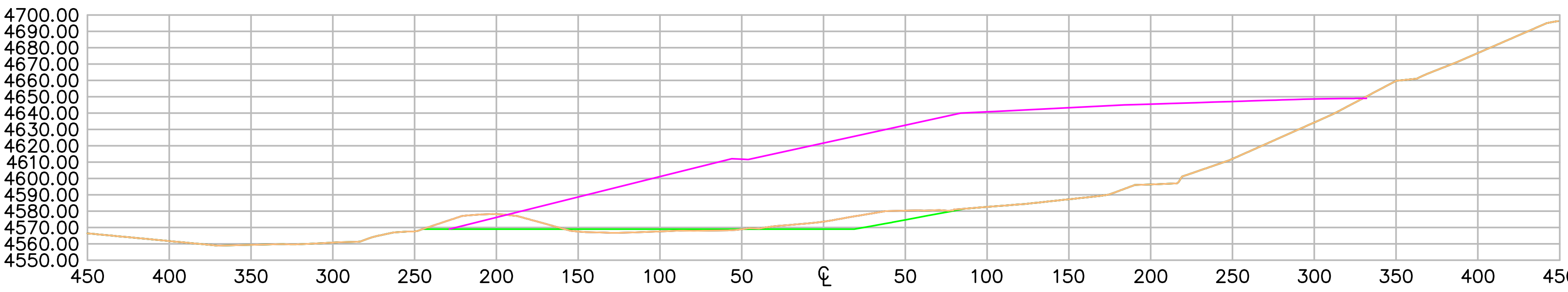

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SEE LEGEND ON FIGURE 3-19

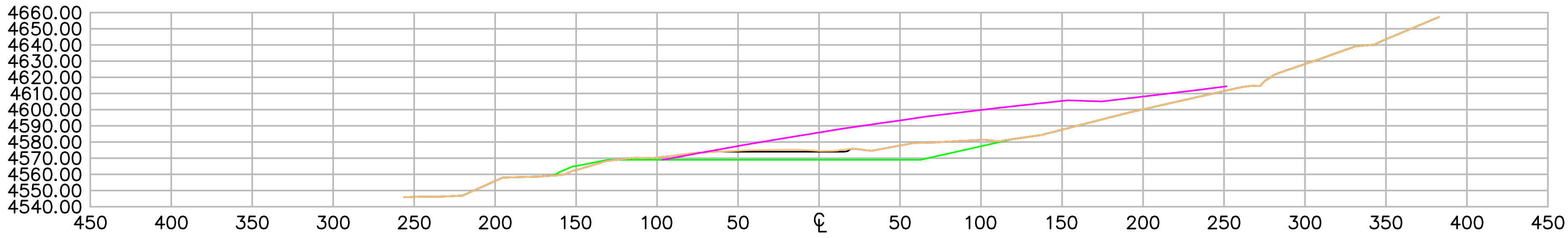
Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

GOLDSIL TAILINGS AREA
CROSS SECTIONS
STATION 25+00 - 27+50

FIGURE
3-24

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416GTsec.dwg



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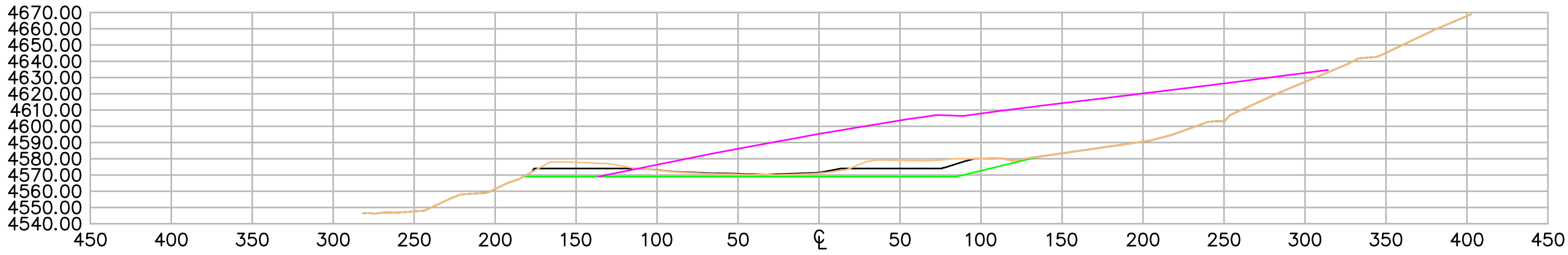

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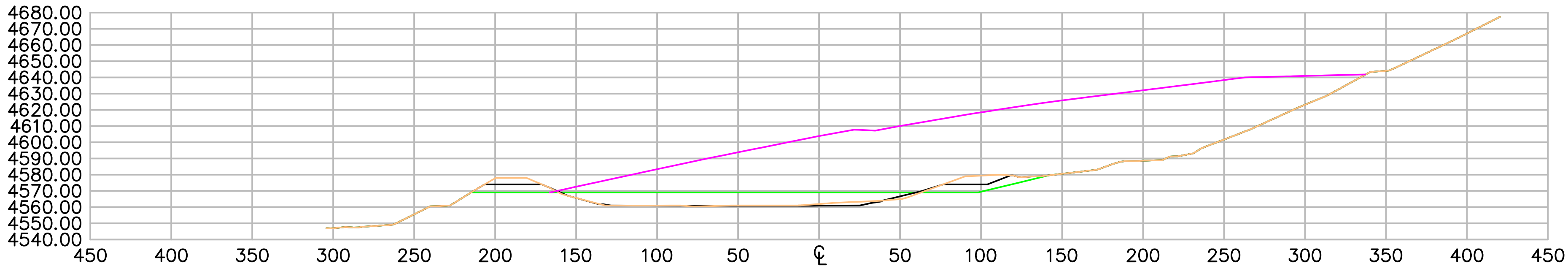

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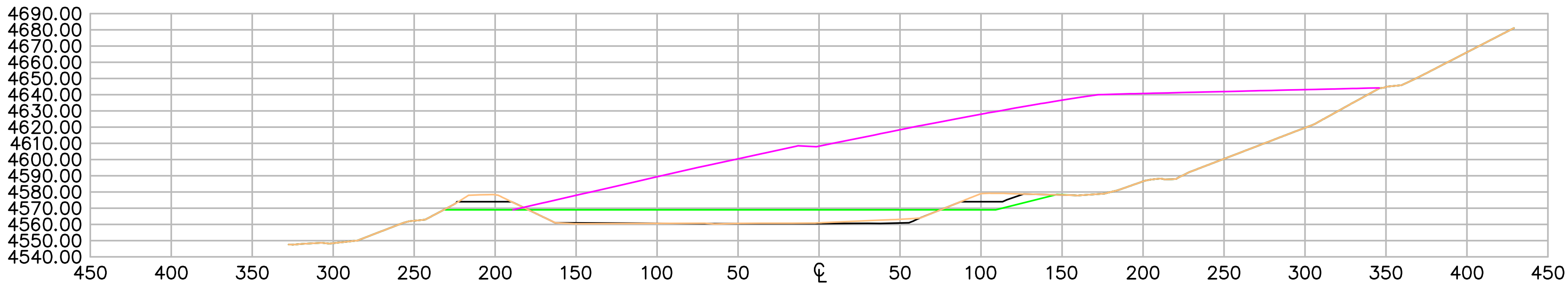

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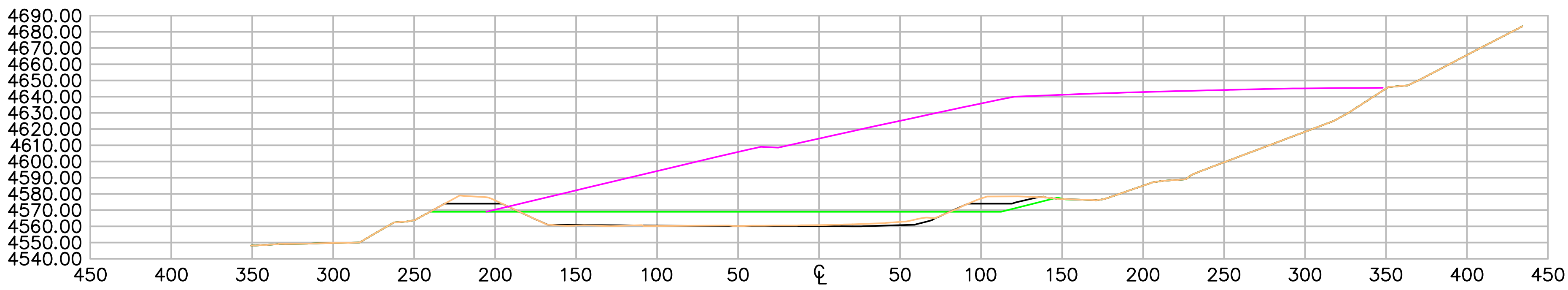

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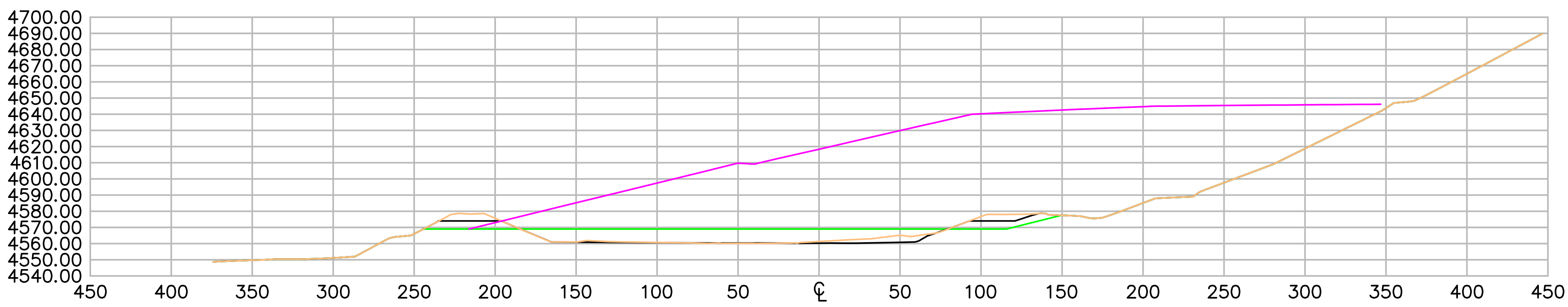

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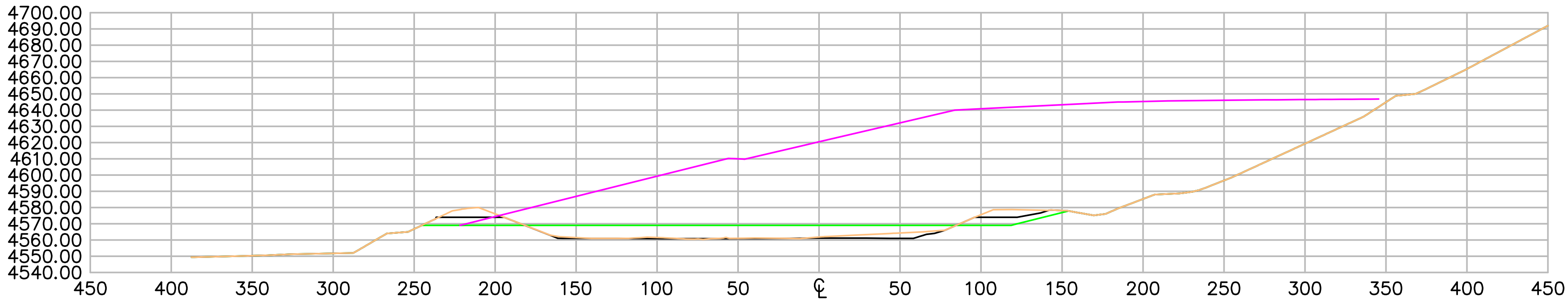
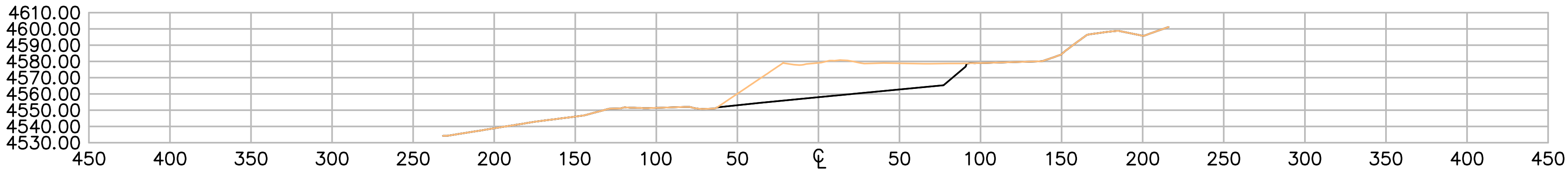


STA =28+00

SEE LEGEND ON FIGURE 3-19

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	GOLDSIL TAILINGS AREA CROSS SECTIONS STATION 28+00 - 31+00	FIGURE 3-25

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416GTsec.dwg



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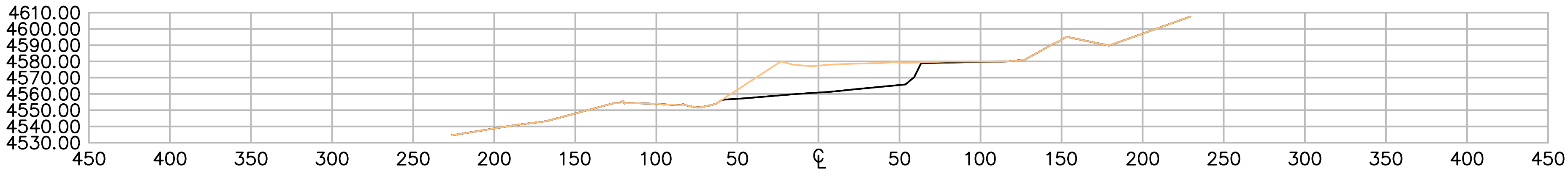

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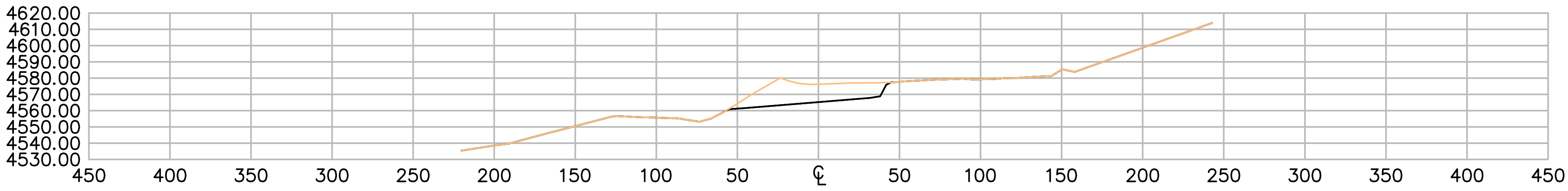

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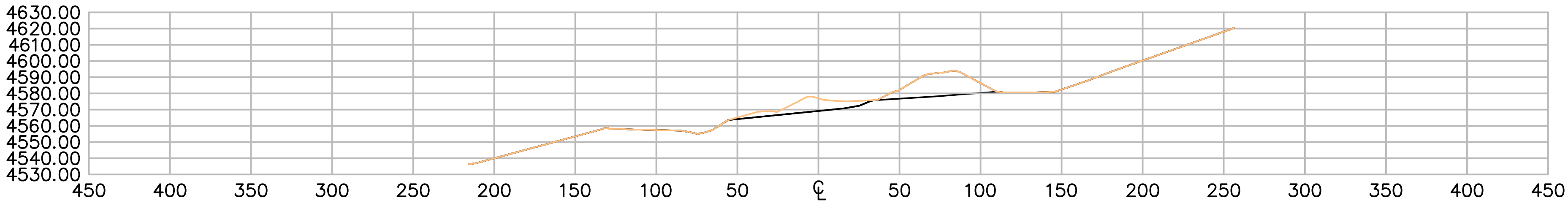

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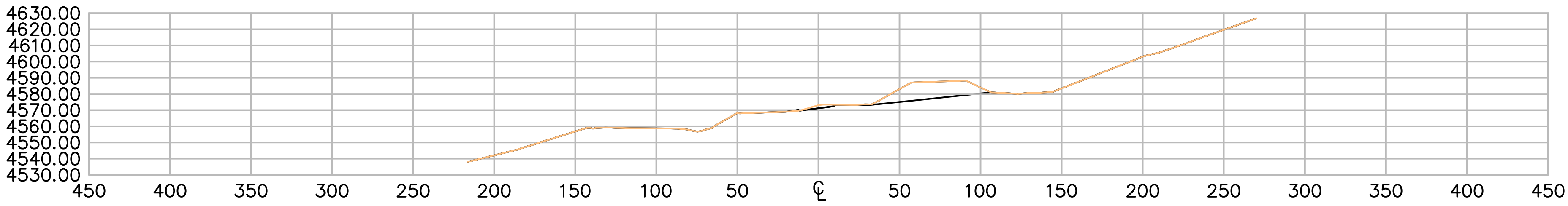

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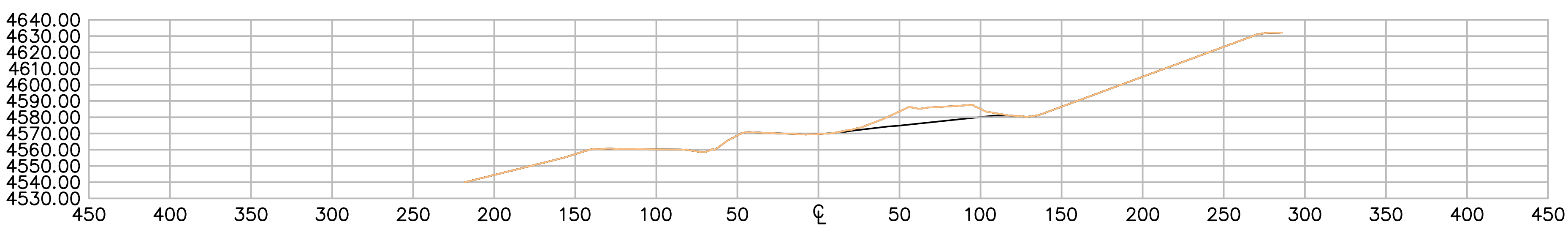

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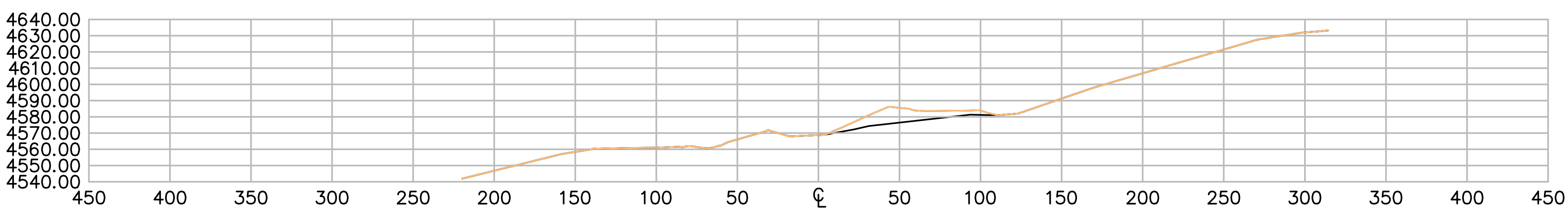

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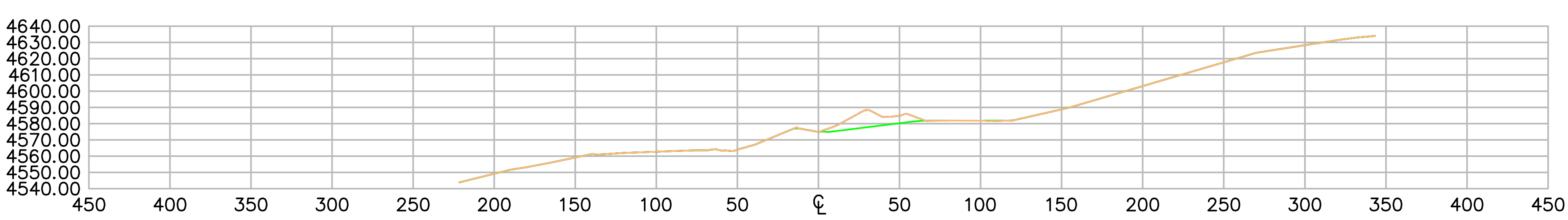

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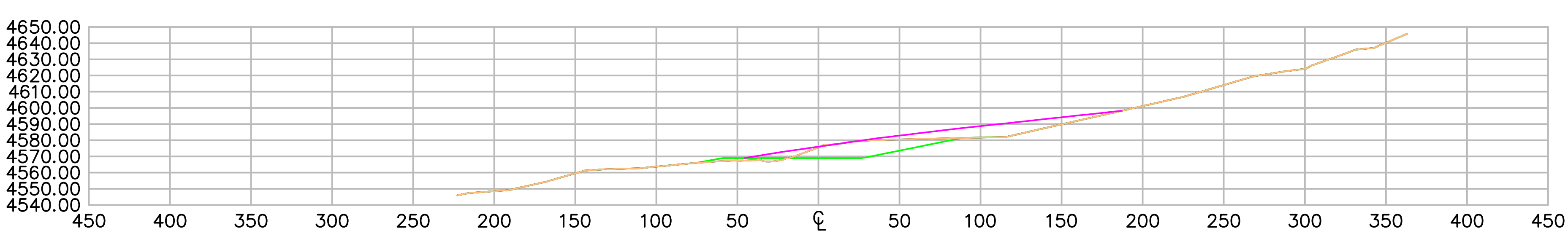


STA =31+50

SEE LEGEND ON FIGURE 3-19

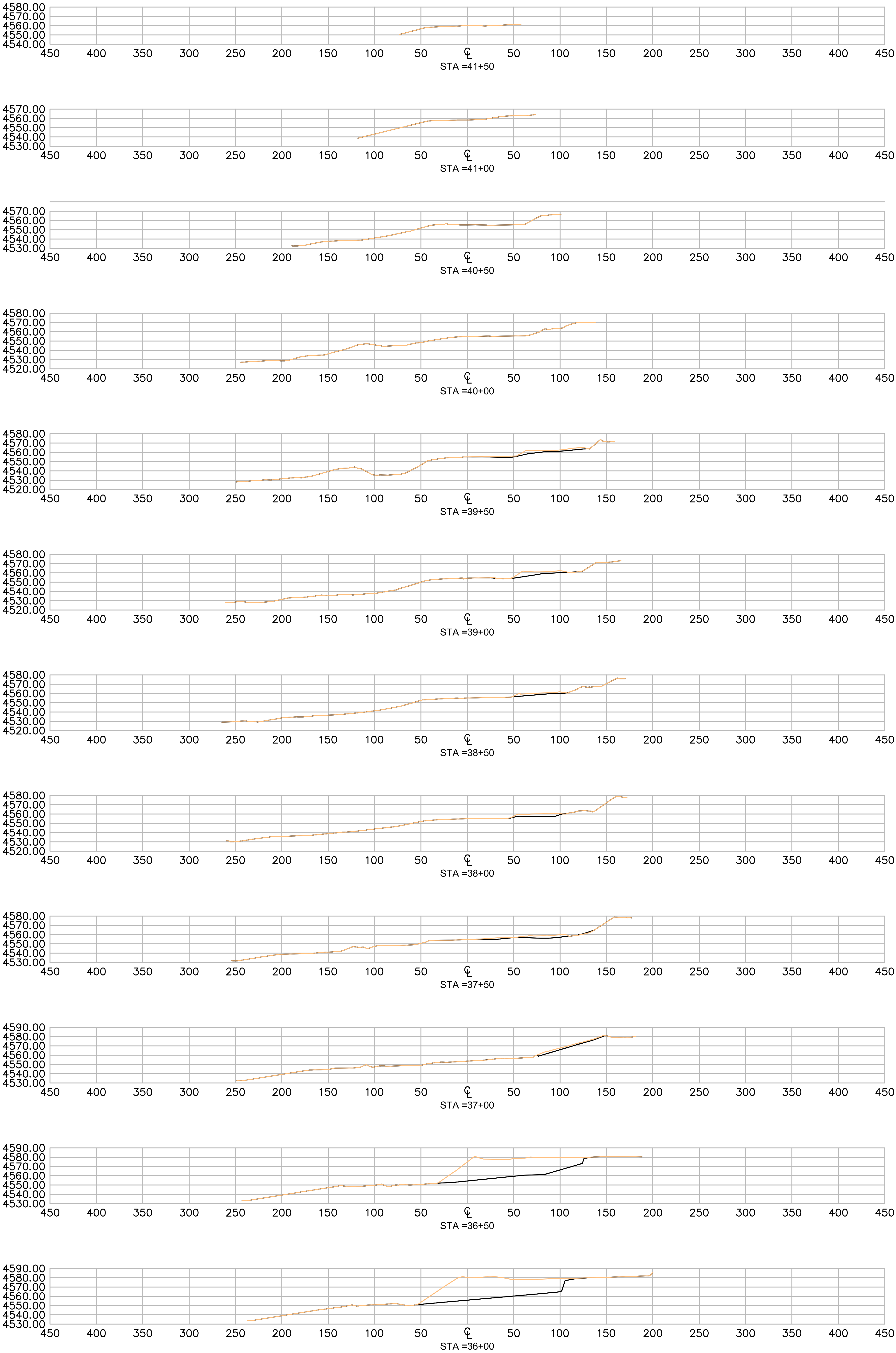
Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

GOLDSIL TAILINGS AREA
CROSS SECTIONS
STATION 31+50 - 35+50

FIGURE
3-26

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416GTsec.dwg



SEE LEGEND ON FIGURE 3-19

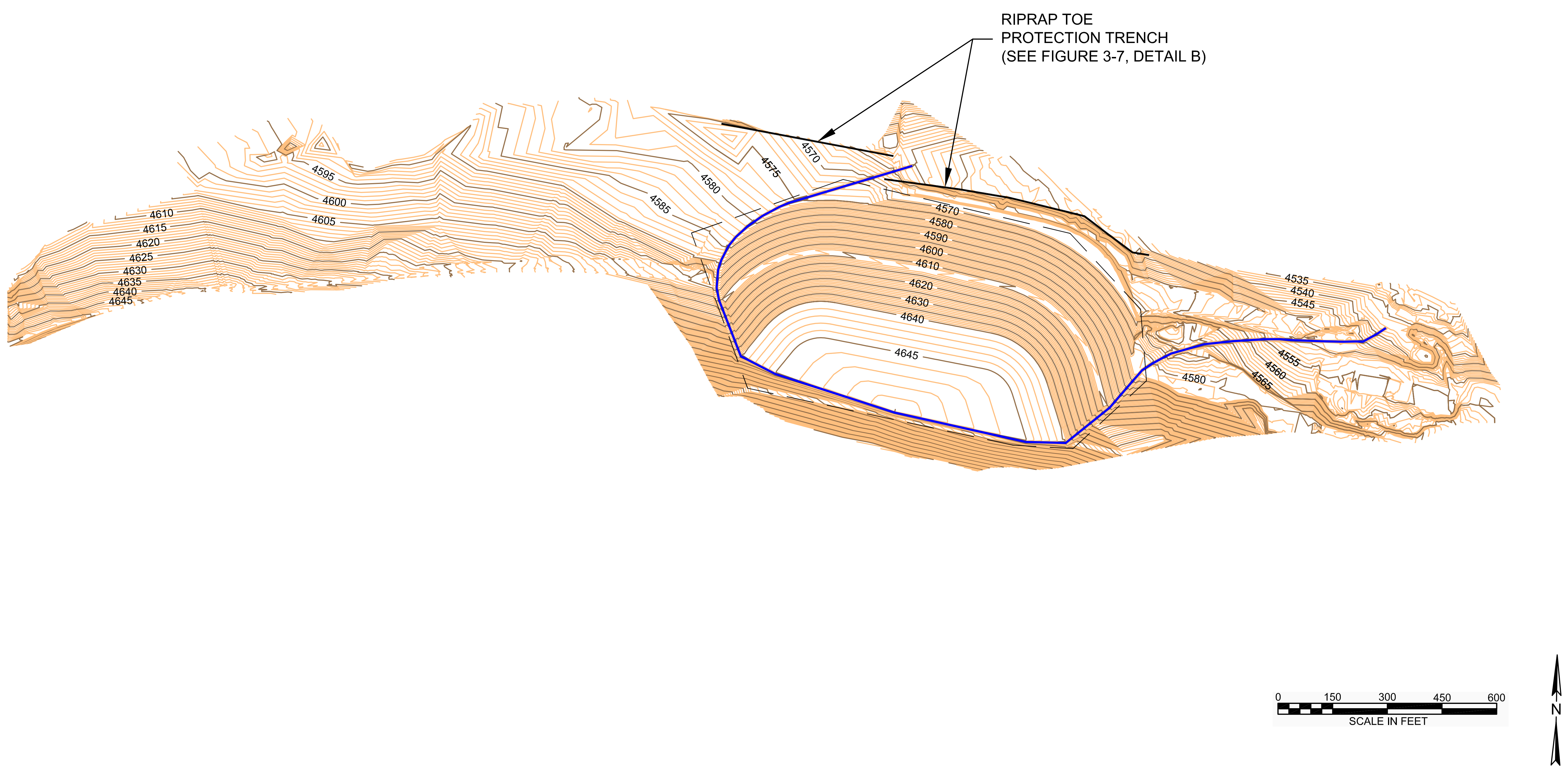
Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

GOLDSIL TAILINGS AREA
CROSS SECTIONS
STATION 36+00 - 41+50

FIGURE
3-27

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416GTsec.dwg



NO.	REVISION DESCRIPTION	BY	DATE	DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	GOLDSIL MILLSITE AND TAILINGS AREA APPROXIMATE POST-RECLAMATION TOPOGRAPHY	FIGURE 3-28
				APPROVED: KSR	DATE: 6/2004	JOB NO: A1416				
				SCALE: AS SHOWN	FILENAME: A1416GT.dwg					

3.2.4 Upper, Middle and Lower Pond Areas

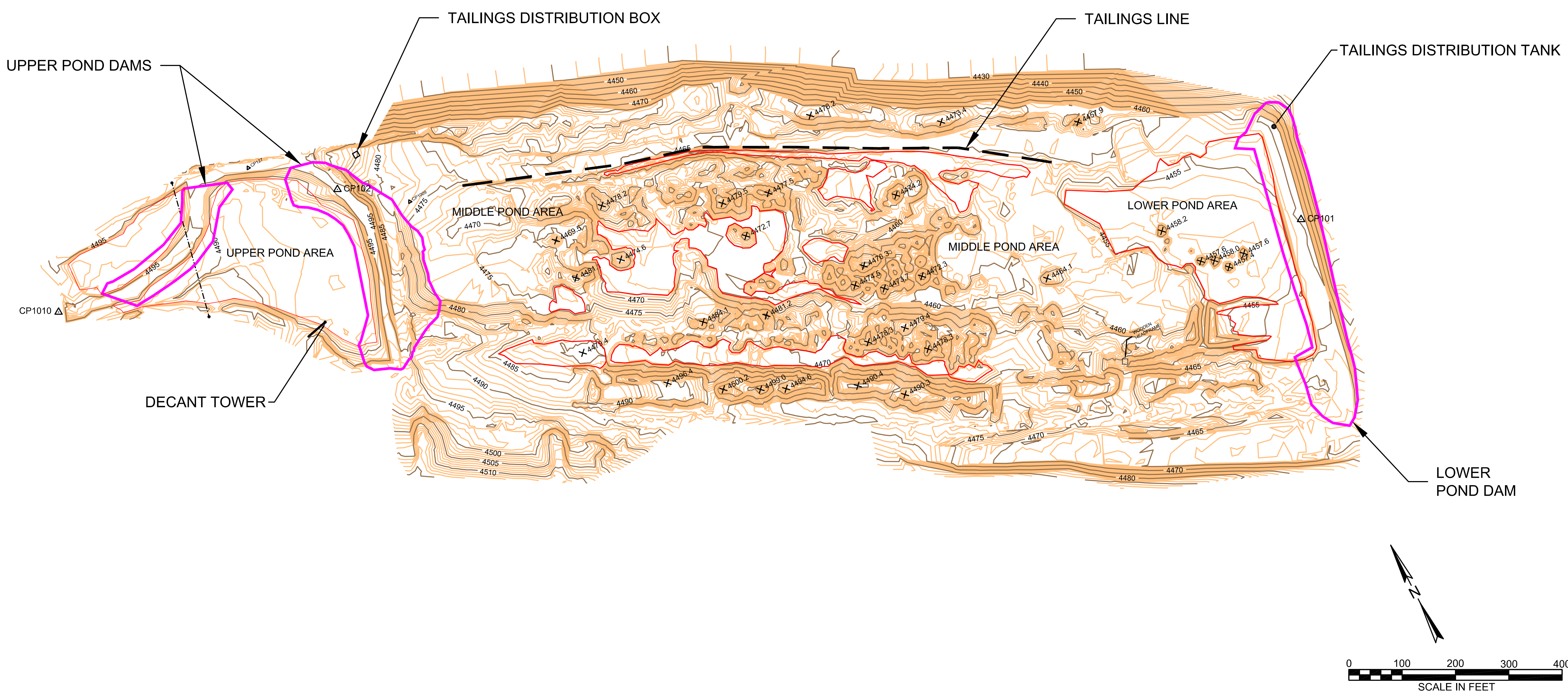
Topographic surveys of the Upper and Lower Pond areas were completed as part of the Phase II site characterization. The Middle Pond area was not surveyed in detail during the site characterization activities. To support the final design, a topographic survey of the Middle Pond area was completed. Figure 3-29 shows the existing topography of the combined Upper, Middle and Lower Pond areas.

The reclamation plan for the Upper, Middle and Lower Pond areas includes:

- the removal of mill tailings from the Upper, Middle and Lower Pond areas and relocation of the waste in the Goldsil Repository;
- removal and disposal of the tailings pipeline remnants and other debris from the Middle Pond area;
- recovery and stockpiling of native soil material from the Upper and Lower Pond dams for use as cover soil;
- grading of placer tailings in the Middle and Lower Pond areas; and
- placement of cover soil from the Upper and Lower Pond dams over the graded waste source areas and the graded placer tailings.

There are an estimated 20,720, 11,280, and 17,670 cubic yards of tailings in the Upper, Middle and Lower Pond areas, respectively (49,670 cubic yards total). After these tailings are excavated and relocated in the Goldsil Repository, the native dam material from the Upper Pond dam and a small secondary dam will be salvaged for cover soil. The mounds of placer tailings located primarily in the Middle Pond area will be graded and contoured to provide positive drainage. The Upper, Middle and Lower Pond areas will require an estimated 48,360 cubic yards of cut and fill to achieve the design grading plan. The existing Upper, Middle and Lower Pond area topography and cross section locations are shown on Figure 3-30. Cross sections of the Upper, Middle and Lower Pond areas, showing both the existing and approximate post-reclamation surfaces are shown on Figures 3-31 through 3-35. The grading plan for the Upper, Middle and Lower Pond areas is shown on Figure 3-36.

The Upper and Lower Pond dams (Figure 3-29) contain an estimated 12,480 and 16,030 cubic yards of native fill, respectively. In addition, a third small dam (Figure 3-29) located between the main Upper Pond and a separate lobe of tailings to the northwest contains an estimated 4,840 cubic yards of native soil material. These native soils will be recovered and spread over the graded Upper, Middle and Lower Pond areas. The combined 33,350 cubic yards of native soil material that is expected to be recovered will be spread at an average thickness of 0.9 feet over the 23.02 acres that will be graded. The surface of the Middle Pond area is composed almost entirely of processed placer rock piles and would not likely support vegetation without the addition of cover soil.



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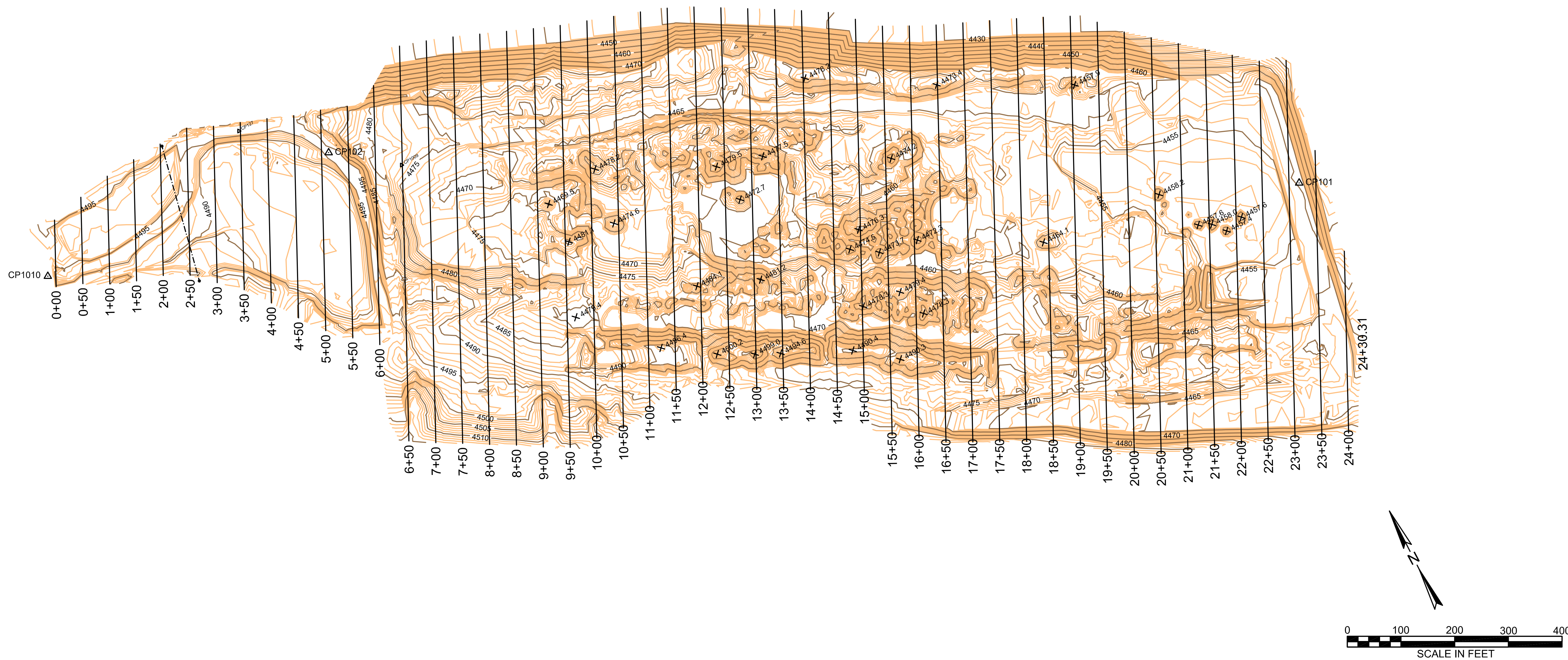
DESIGN:	DRAWN: KSR	CHECKED: CRS
APPROVED:	DATE: 6/2004	JOB NO: A1416
SCALE: AS SHOWN	FILENAME: A1416MPext.dwg	

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

UPPER, MIDDLE AND
LOWER POND AREA
EXISTING TOPOGRAPHY

FIGURE
3-29



NO.	REVISION DESCRIPTION	BY	DATE

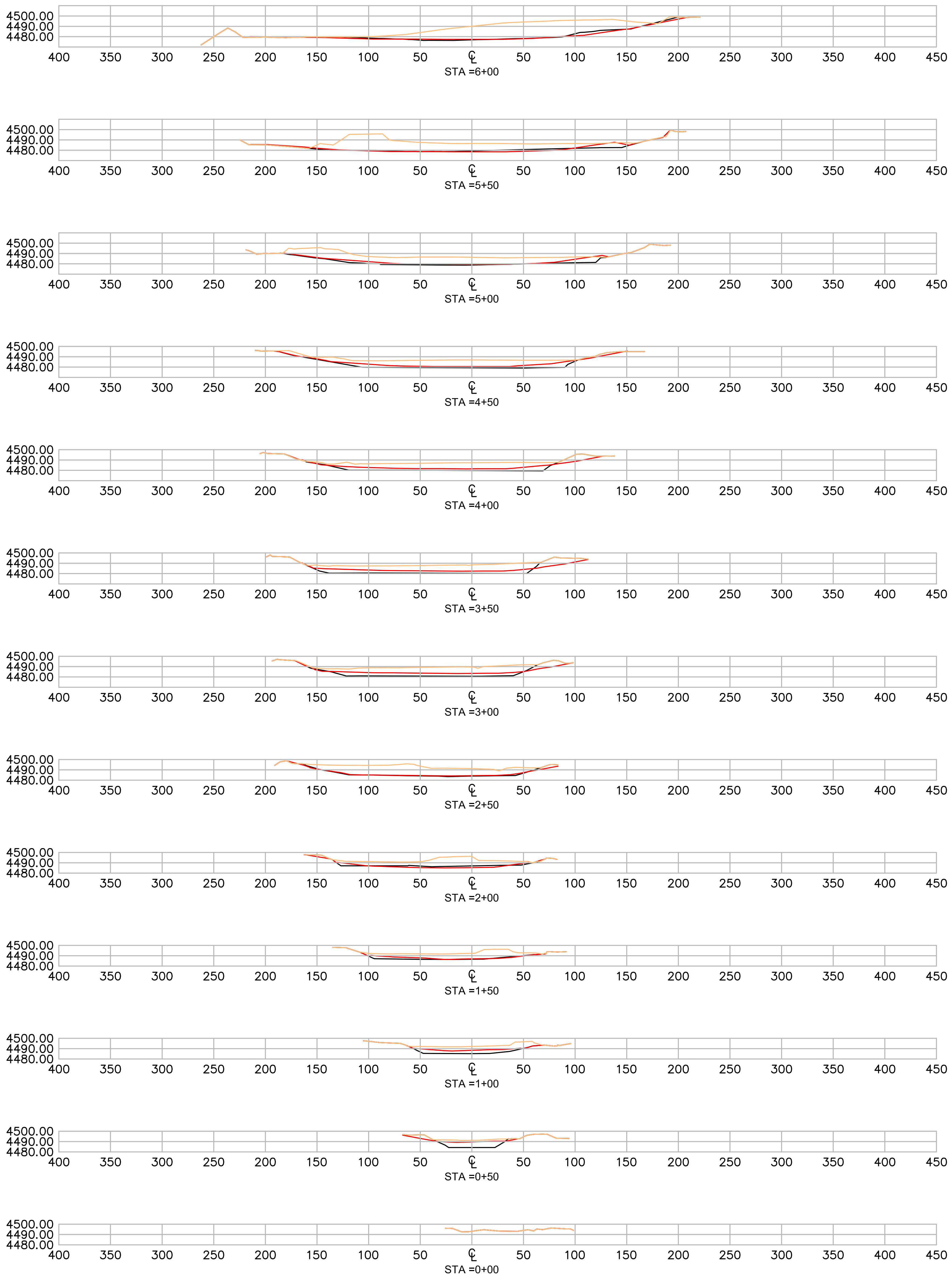
DESIGN:	DRAWN: KSR	CHECKED: CRS
APPROVED:	DATE: 6/2004	JOB NO: A1416
SCALE: AS SHOWN	FILENAME: A1416MPext.dwg	

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

UPPER, MIDDLE AND
LOWER POND AREA
CROSS SECTION LOCATIONS

FIGURE
3-30



LEGEND

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NATIVE SURFACE

GRADED SURFACE

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	UPPER, MIDDLE AND LOWER POND AREA CROSS SECTIONS STATIONS 0+00 - 6+00	FIGURE 3-31

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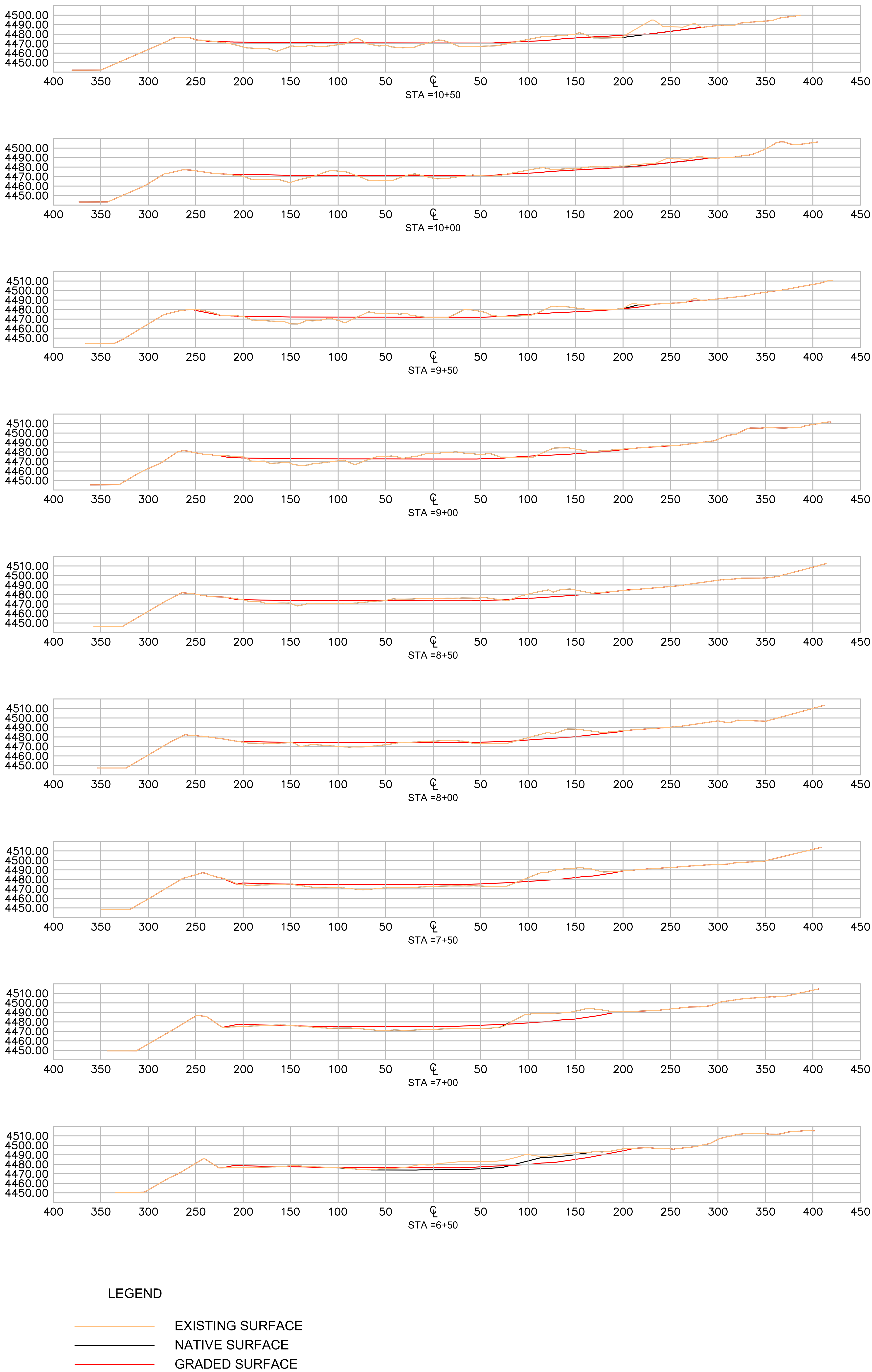

Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	UPPER, MIDDLE AND LOWER POND AREA CROSS SECTIONS STATIONS 6+50 - 11+00	FIGURE 3-32	

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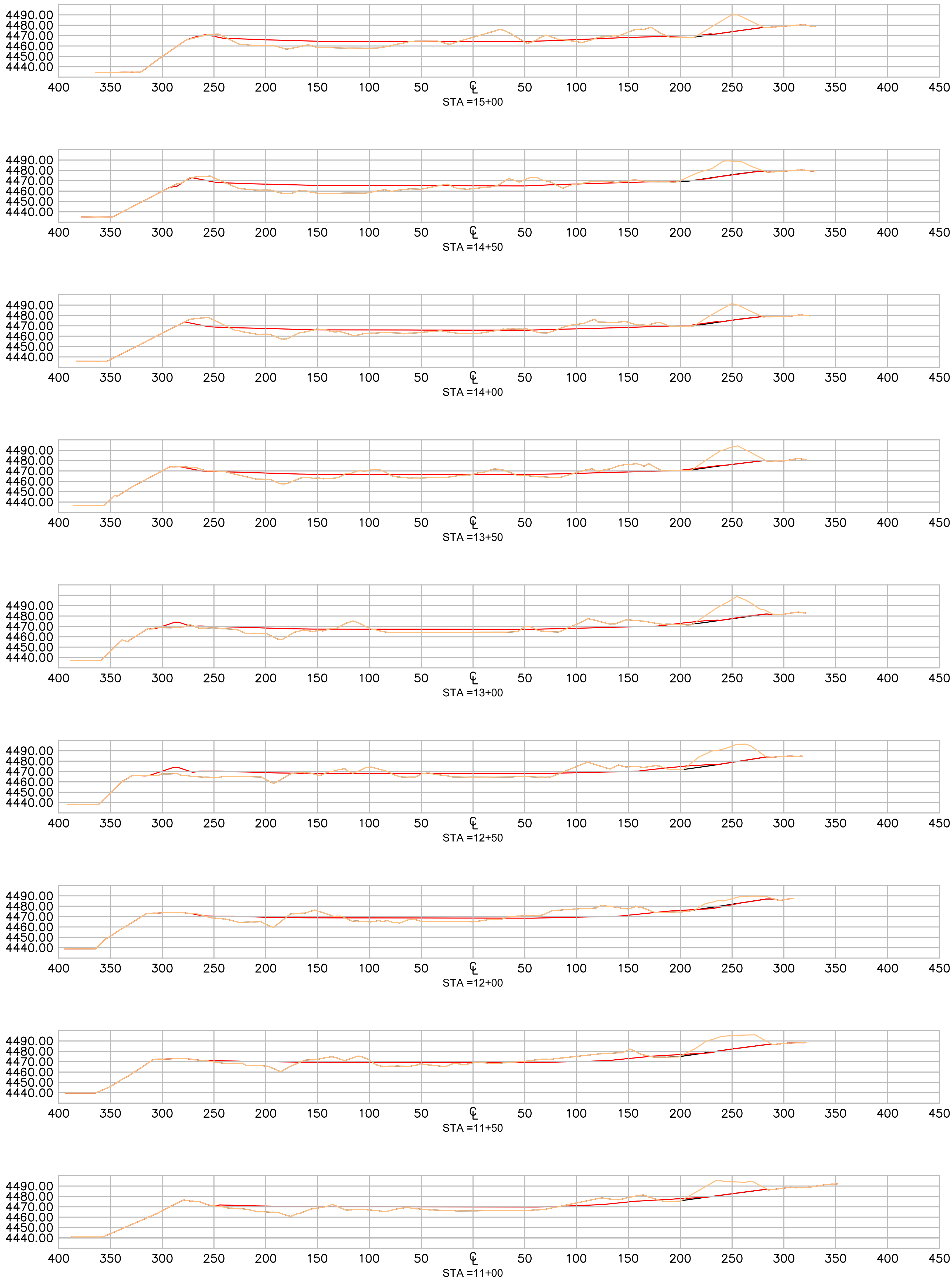

LEGEND

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Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	UPPER, MIDDLE AND LOWER POND AREA CROSS SECTIONS STATIONS 11+50 - 16+00	FIGURE 3-33

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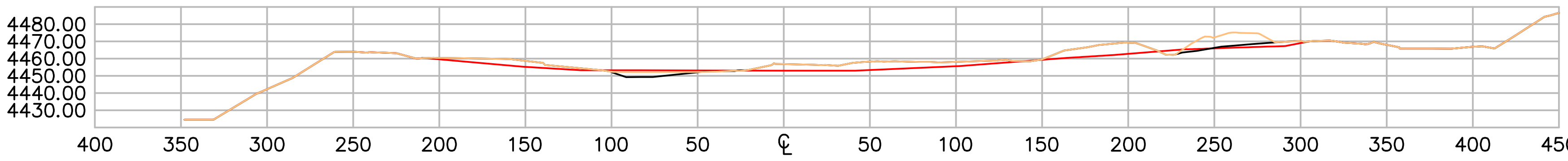

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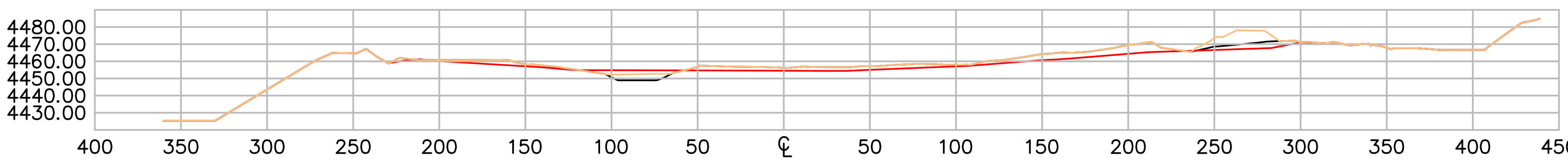

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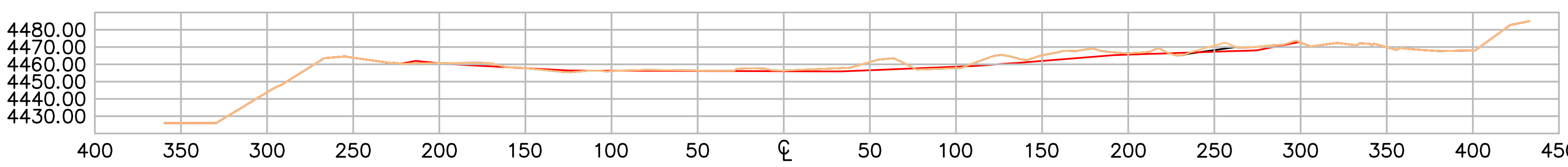

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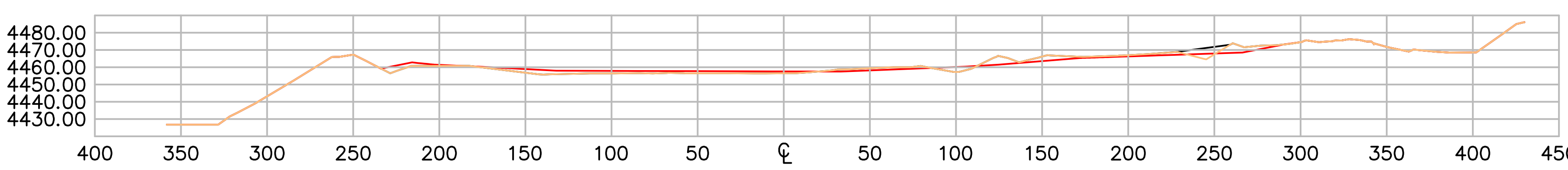

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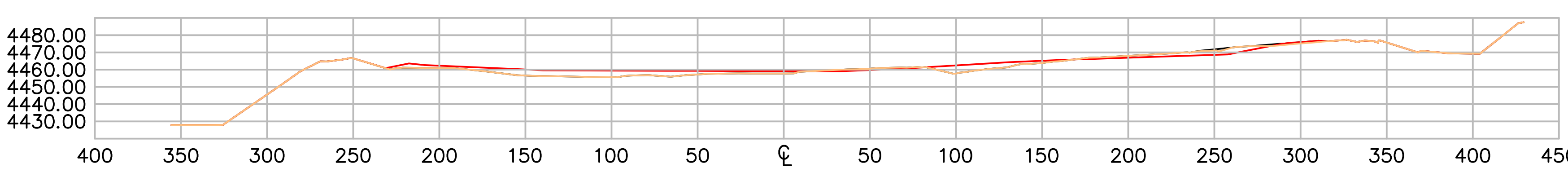

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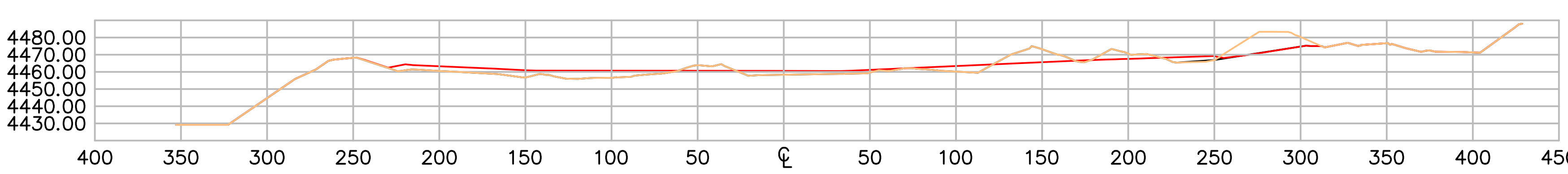

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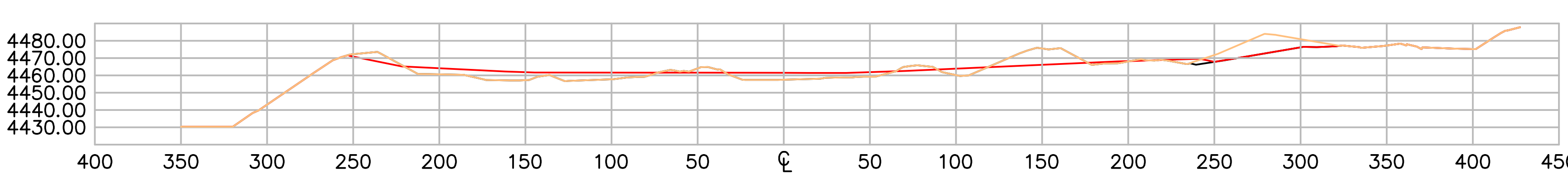

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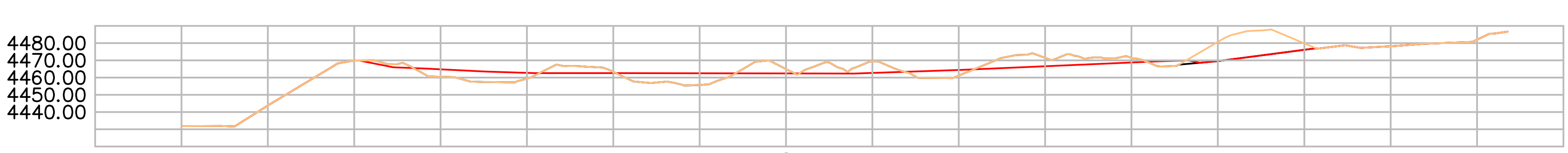

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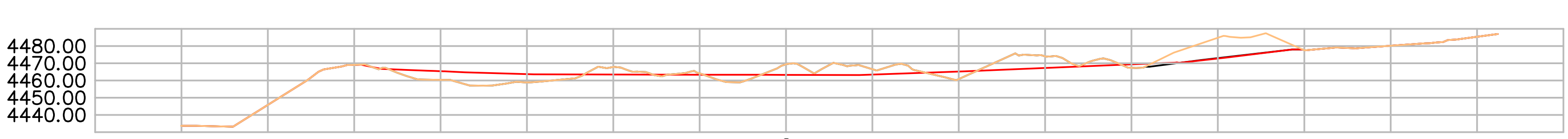

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LEGEND

EXISTING SURFACE

NATIVE SURFACE

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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

UPPER, MIDDLE AND LOWER POND
AREA CROSS SECTIONS
STATIONS 16+50 - 21+00

FIGURE
3-34

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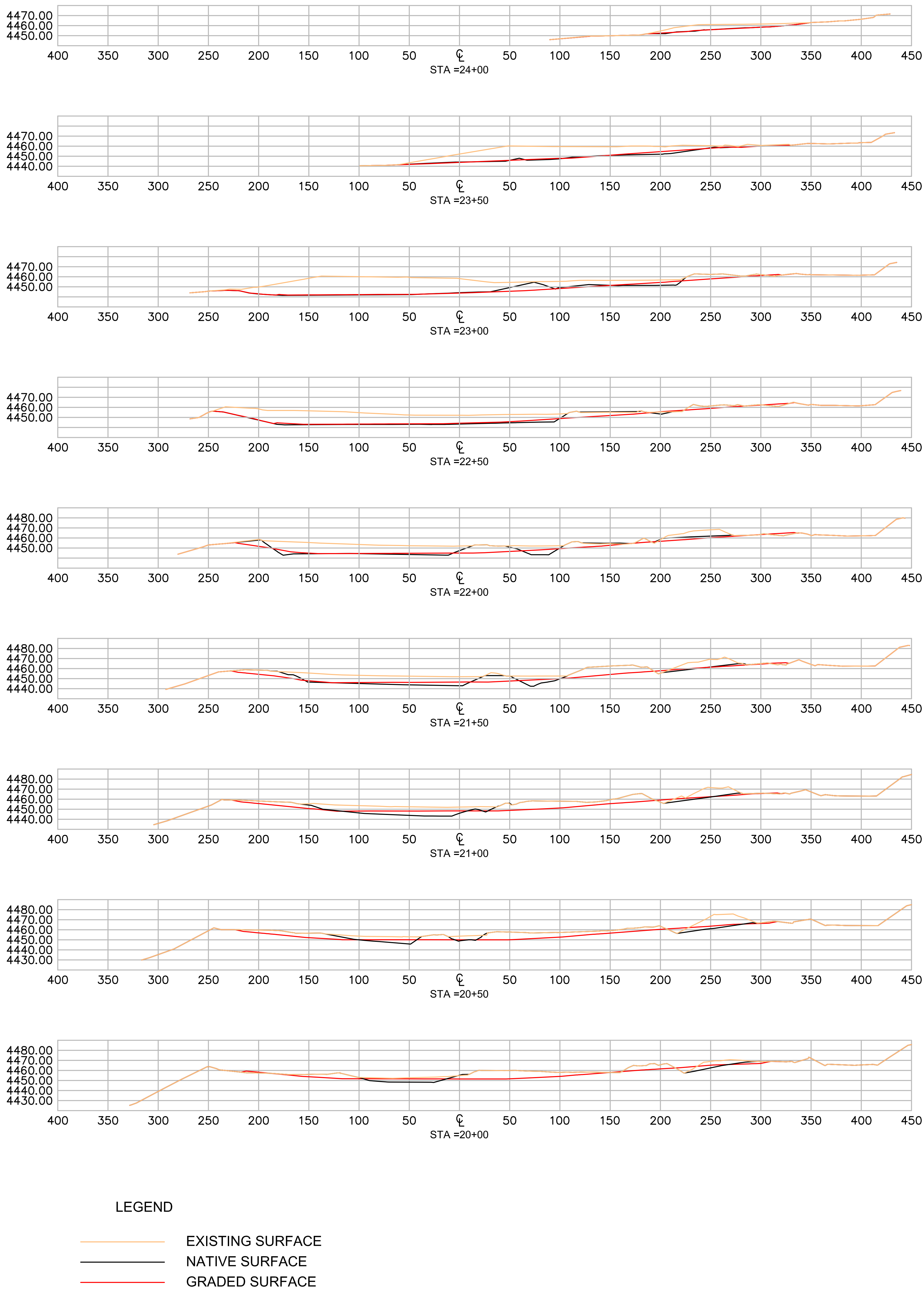

Olympus Technical Services, Inc.		MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	UPPER, MIDDLE AND LOWER POND AREA CROSS SECTIONS STATIONS 21+50 - 24+00	FIGURE 3-35
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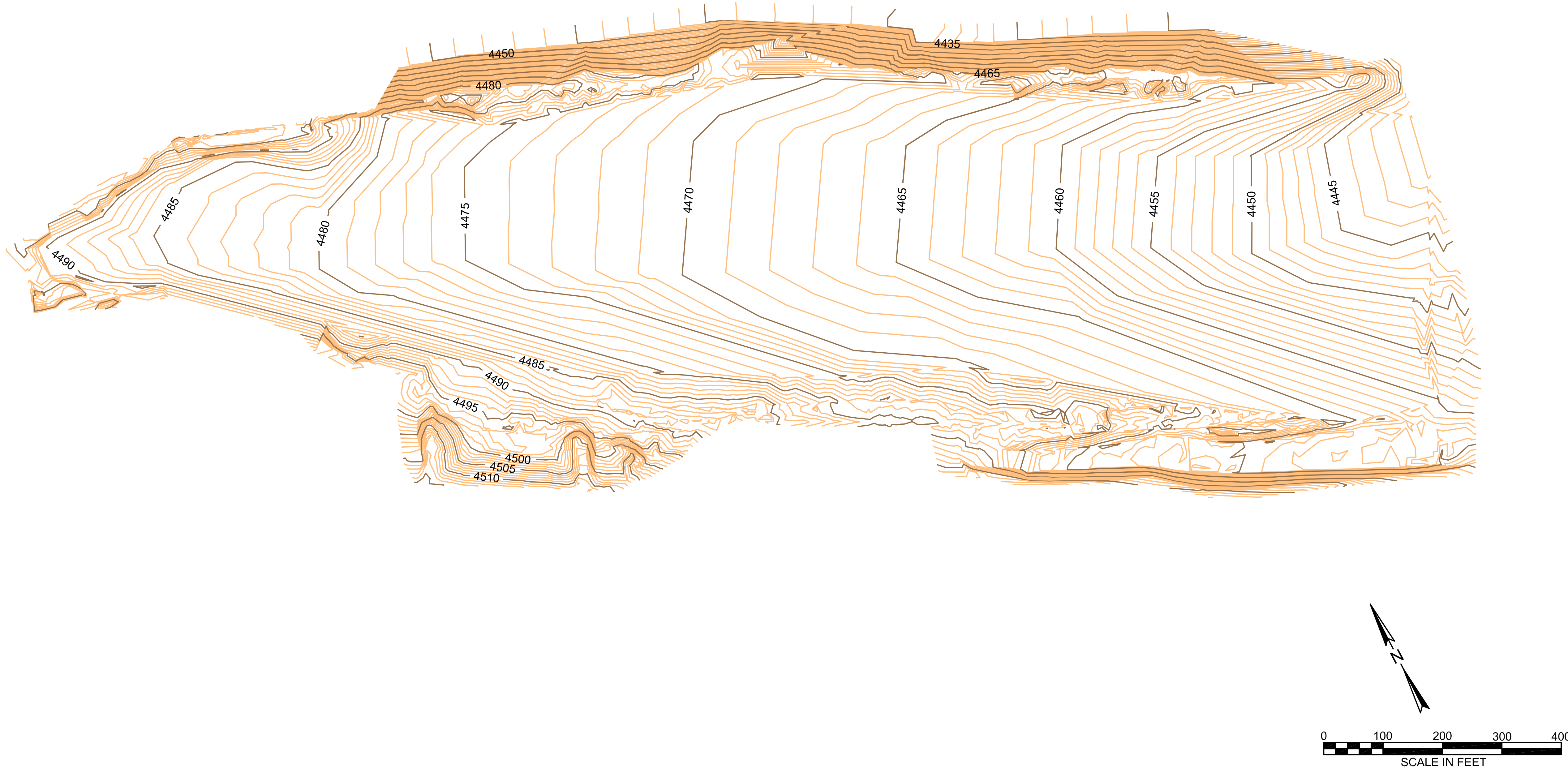

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				APPROVED:	DATE: 3/2004	JOB NO: A1416				
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3.2.5 Wet Tailings Handling

Based on the site characterization results, excessively wet tailings are expected to be encountered in some areas, especially in the Drumlummon tailings (Figure 3-2) and to a lesser extent in the Upper Pond Area. Given the large areal extent of the tailings and the limited number of test pits and drill holes, other wet tailings that have not been identified are likely to be encountered.

Wet tailings areas (i.e., tailings slime layers) that are encountered in the excavation shall be spread in thin layers on the repository and blended with sandy/silty tailings so that the slime layers are not concentrated in any portion of the repository. Excessively wet tailings shall be spread to a depth no greater than 1 foot on the repository surface to allow exposure to air and sunlight for adequate time to dry. Periodic mixing for aeration may also be required. As directed by the Engineer, if free water is encountered while excavating the lower portion of tailings, the Contractor may be required to construct temporary settling basins and/or berms, as necessary, to contain the water.

3.3 DEBRIS REMOVAL AND DISPOSAL

Wood, metal and concrete debris are present in several locations in the project area. The following is a summary of the known debris and other non-tailings items that will require disposal or special handling:

- metal pipes and an old wooden flume structure at Drumlummon millsite tailings pile TP-1;
- trees and shrubs at the Drumlummon millsite tailings piles TP-1, TP-2 and TP-3;
- wooden dam cribbing, trees, shrubs and willows at the Drumlummon tailings;
- trees, shrubs, wooden dam cribbing, a core shack with core samples and pond liner at Goldsil tailings area;
- trees in the repository area at the Goldsil tailings area;
- two bone yard areas with metal debris and empty cyanide drums, a concrete retaining wall, a ball mill, ball mill foundation, concrete mill slab, metal tank bottoms and a solid waste pit at Goldsil Millsite area;
- trees and willows, a decant tower and tailings distribution box at the Upper Pond area;
- a wooden tailings pipeline, wooden pipeline trestle and some trees at the Middle Pond area;
- a tailings distribution box with hoses and a wooden headframe at Lower Pond area; and
- an abandoned camp trailer and other solid waste south of the Upper Pond.

Trees, shrubs and willows (i.e., construction slash) will be cleared and grubbed from tailings piles prior to tailings removal. The construction slash will be scattered on the reclaimed tailings source areas after fertilizing, seeding, and mulching have been completed to provide erosion control and small game habitat. Some willows will need to be cut and preserved for the stream reconstruction through the Drumlummon tailings area (Section 3.2.2.3).

Other wood debris items, such as dam cribbing, the core shack and wooden tailings pipe and trestle will be stockpiled and burned on site. The wooden tailings piping has metal bands that must be recovered and disposed of after burning.

Metal debris will be removed from the site and recycled, if possible. Any metal items that are not acceptable for recycling will disposed of at a Class II solid waste landfill. Metal debris that has tailings residue will be washed prior to recycling or disposal. Wash water will be collected and used for dust control on tailings areas or for moisture conditioning of tailings for compaction. Other non-concrete and non-wood solid waste/debris will be disposed of at a Class II solid waste landfill.

There are several areas of concrete debris at the site, particularly in the Goldsil millsite area. These include a retaining wall in the Goldsil ramp tailings area, a concrete ball mill foundation, the concrete mill floor slab and another concrete slab located east of the former mill building. The concrete debris shall be broken into pieces that are no larger than 1 foot in any dimension and placed in the repository. The concrete most likely contains rebar and may require the use of a hydraulic hammer, rock breaker or other such equipment to achieve the size limit. The size limit on concrete pieces is to provide for adequate compaction around concrete debris so that excessive voids will not be created. Concrete debris shall be placed in lifts not to exceed 1.5 feet in thickness and shall be compacted with tailings. Concrete debris shall not be concentrated in a single region in the repository. Concrete debris shall not be placed within 10 feet of the repository cap and liner.

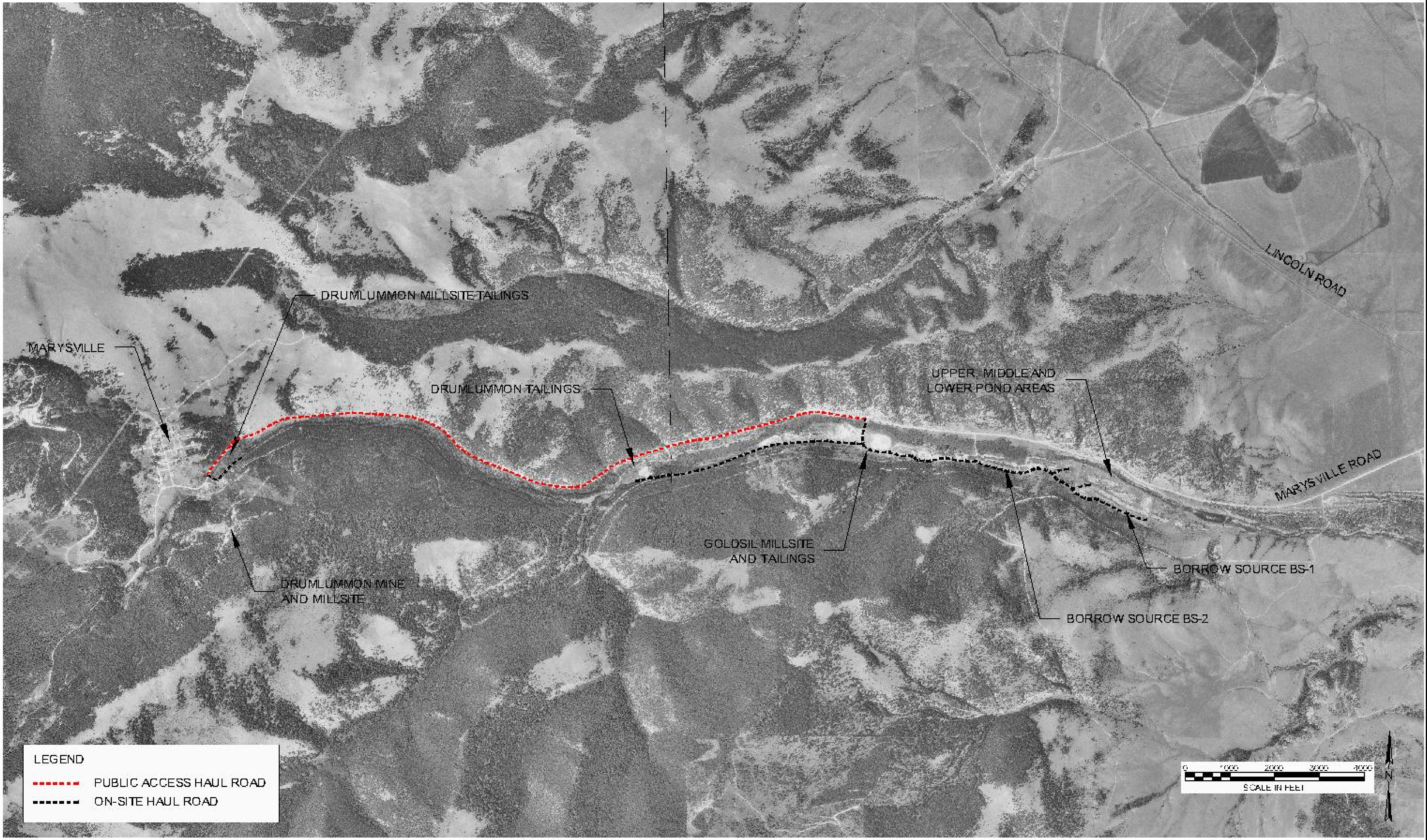
3.4 CONSTRUCTION PLAN

3.4.1 Haul Route Design and Safety Controls

Haul routes for moving tailings to the repository area are for the most part already in place. Figure 3-37 is an aerial photograph that shows the proposed haul routes for each of the waste sources. The following is a summary of each haul route:

- Removal of the Drumlummon millsite tailings will require the use of the main Marysville Road to relocate the tailings in the repository. This haul route has the most exposure and overall risk to the general public. Safety measures, such as signs and possibly flaggers at the intersections of the Drumlummon millsite and the Goldsil millsite access road, will need to be implemented. The Contractor who completes the work will be required to prepare a traffic control plan and submit it to the Montana Department of Transportation for review and approval prior to the start of work.

- An existing road that leads from the Goldsil tailings to the Drumlummon tailings area will be used as the haul road for the removal of the Drumlummon tailings. This is a single-lane road that should require little improvement, with the exception of the construction of turnouts to allow two-way haul traffic. The road follows along the southern perimeter of the main Goldsil tailings and passes south of the Drumlummon tailings. There is an existing spur road that leads from the proposed haul road down to the Drumlummon tailings. However, this road is steep and narrow and will require improvement to allow haul truck traffic.



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE CHARACTERIZATION
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

PROPOSED HAUL ROUTE LOCATIONS

FIGURE 3-37

- The removal of the Goldsil tailings to the repository will not require formal haul road construction. The repository is located in the general area of the Goldsil tailings, and covers a portion of the Goldsil tailings area. Localized haul roads, to be established by the Contractor, will be used for transporting tailings to the repository.

- An existing access road leading from the Goldsil millsite area to the Upper, Middle and Lower Pond areas will be used for transporting tailings from the Upper, Middle and Lower Pond tailings areas to the repository area. This is a single-lane road that should require little improvement, with the exception of the construction of turnouts to allow two-way haul traffic, and some possible widening in some areas. An overhead electrical power line parallels the haul road in some areas, and all road improvements must avoid and protect the power line.

- Transportation of borrow soil from borrow sources BS-1 and BS-2 will use the same haul route as the Upper, Middle and Lower Pond areas.

3.4.2 Construction Phases and Sequencing

The work to be completed as part of the Silver Creek Drainage Project is large enough that it will take several construction seasons to complete. The number of construction seasons that are required will be controlled largely by the funding that is available each year to complete the project, as well as the work quantities and the feasible duration of seasonal construction.

The proposed sequencing is based primarily on haul road logistics. The existing road that passes through the Goldsil Millsite and the proposed repository area will be covered up as the repository is advanced. Therefore, it is proposed that the outlying tailings areas, such as the Drumlummon tailings and Upper, Middle and Lower Pond area tailings be excavated prior to losing the use of the existing road. The main road to Marysville will have to be used to haul the Drumlummon millsite tailings. This will likely require the use of on-road dump trucks rather than off-road trucks. Whereas off-road dump truck or scrapers, are suited for climbing steep slopes to deposit tailings on the higher elevations of the repository, on-road trucks are not. Therefore, it is preferable to remove the Drumlummon millsite tailings piles first so that they can be placed directly on the repository base with on-road trucks. The Drumlummon tailings and Upper, Middle and Lower Pond area tailings are proposed for removal and placement in the repository after the Drumlummon millsite tailings. This will allow the maximum use of existing haul road prior to it being closed with tailings lifts in the repository area. Finally, the Goldsil Millsite tailings and the main Goldsil tailings, which are the closest to the repository, would be excavated and placed in the repository. Based on this rationale, the proposed construction sequencing for the Silver Creek Drainage Project is as follows:

1. Removal of tailings from within the repository base preparation area.

2. Preparation of the repository base and filling in lined pond area.

3. Removal of Drumlummon millsite tailings.

4. Removal of Drumlummon tailings.

5. Removal of Upper, Middle and Lower Pond area tailings.

6. Removal of Goldsil Millsite tailings.

7. Removal of Goldsil tailings.

8. Final repository closure.

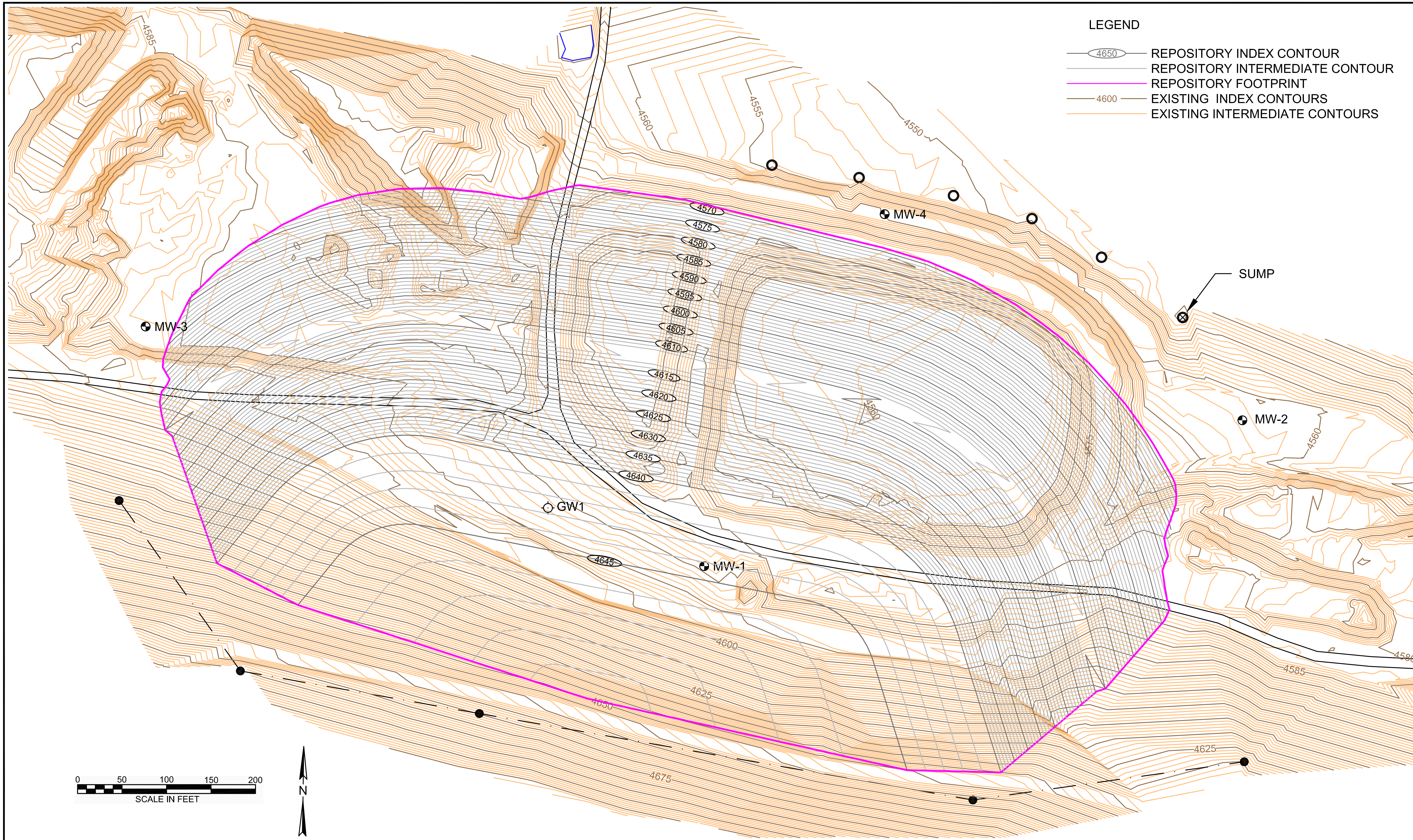
3.5 REPOSITORY DESIGN

Silver Creek and its floodplain are located in a steep, narrow, mountainous drainage basin where the land ownership is almost exclusively private. The potential areas for mine/mill waste repositories are limited. During the Phase II site characterization, a potential mine/mill waste repository site near the central portion of the Goldsil tailings area was investigated (Figure 3-16). This work involved assessing land ownership, estimating potential repository storage volume and preliminary design, construction logistics, and an evaluation of the subsurface geology and shallow groundwater.

Site characterization and risk assessment results indicate that the mill tailings represent the most significant source of contaminants for impacting human health and the environment. The total estimated volume of mill tailings in the Silver Creek drainage is approximately 612,000 cubic yards. The mill tailings and potential borrow sources for repository cover soils are located in an area that is nearly four miles long. Given these data and logistics, a repository site at the Goldsil tailings area was selected for evaluation based on the following criteria:

- Area which could accommodate the estimated mill tailings volume;
- Area which would have a reasonable chance of getting land ownership approval;
- Area which would provide for an acceptable buffer zone with Silver Creek and its floodplain;
- Area which would be somewhat central to all of the mill tailings areas;
- Area which has existing potential secondary roads that could serve as haulage route(s);
- Area which is reasonably close to the largest mill tailings volume;
- Area which is a reasonable distance from potential borrow source soil cap materials; and
- Area which would require a limited amount of waste excavation to prepare a portion of the repository pad to initiate waste loading operations.

Based on the above criteria, a repository site was selected in the area of the lined tailings impoundment located within the Goldsil tailings area. The property is exclusively owned by the St. Louis Drumlummon Mines, Inc. Figure 3-38 shows the repository site area, the existing topography and design topography. The design indicates that the repository would occupy 12.72 acres, have a maximum waste thickness of 72 feet, and could accommodate an estimated 674,500 cubic yards of waste. This includes a 10.2 percent contingency in excess of the known 612,000 cubic yards of mill tailings to accommodate additional tailings and impacted soils that may be encountered.



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

GOLDSIL MILLSITE AREA
EXISTING AND REPOSITORY
DESIGN TOPOGRAPHY

FIGURE
3-38

The repository subgrade consists of colluvium and/or alluvium down to limestone bedrock. The depth to bedrock is estimated at 44 feet or less below the surface based on previous wells completed in bedrock by Lindsey Drilling in 1974 for Silver Creek Mining. Static water levels (December 4, 2002) in groundwater monitoring wells completed by Olympus in the repository area indicate that the water table in the alluvial aquifer would be 14.4 to 25.7 feet below the existing topographic surface. Groundwater flow is at a relatively steep gradient and flow direction essentially parallels Silver Creek in this area. Figure 2-1 shows the potentiometric surface in the vicinity of the repository.

3.5.1 Base Preparation

Preparation of the repository base will include clearing and grubbing of trees from the repository area, earthwork and grading to provide a suitable repository base, and the removal and closure of wells GW1 and MW-1. Well GW1 is an existing well located near the core shack. Olympus attempted to measure the water depth in well GW1 in 2002, however, an obstruction in the well prevented any measurements from being made.

The base elevation of the existing lined pond in the Goldsil tailings areas is at an elevation of 4560 feet near the center and 4570 near the southwest corner. After removal of tailings wastes, the ground surface elevation in the southwest corner of the lined pond will be approximately 4562 feet. The potentiometric map (Figure 2-1) shows that groundwater was at an elevation of 4560 feet near the southwest corner of the lined pond in December of 2002. This puts the water level near the bottom of the tailings. These measurements were collected in December, which is probably a period of lower static water levels. In an effort to keep groundwater from intersecting tailings in the repository, the repository base will be graded to raise the base level in the vicinity of the lined pond area. After the tailings have been removed from inside of the lined pond and the lined pond berm, the base elevation of the repository will be raised to an elevation of 4569 feet to provide separation between the tailings and the groundwater surface. This will be accomplished by cutting the area west of the lined pond and using the cut material to fill in and raise the lined pond area. This will require approximately 28,250 cubic yards of cut and fill. Prior to obtaining this fill, approximately 11,020 cubic yards of tailings must be removed from the east end of the main Goldsil tailings pile to allow access to this fill material. The tailings in the lined pond (3,440 cubic yards) and the lined pond berm (7,550 cubic yards) will also be removed prior to base grading. These 22,010 cubic yards of tailings that will initially be removed from the repository footprint area can possibly be placed in the southern portion of the repository (outside of the base grading area) or may require temporary stockpiling and double handling. In addition, the "ramp" pile to the east of the repository area will be removed and stockpiled for use as borrow soil. The ramp pile contains an estimated 4,750 cubic yards. Figure 3-39 shows the projected native surface below the tailings and the base grading plan for the repository area.

The repository base fill shall be compacted to 90% of Standard Proctor (ASTM D-698/AASHTO T 99) maximum dry density at ±4 percent of the optimum moisture content. The remaining repository base must be prepared by scarifying the repository base to a minimum depth of 12-inches and re-compact to 90% of Standard Proctor (ASTM D-698/AASHTO T 99) maximum dry density at ±4 percent of the optimum moisture content.

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				APPROVED: KSR	DATE: 6/2004	JOB NO: A1416				
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3.5.2 Repository Toe Riprap Protection

The existing slope that will be below the toe of the repository will act as a buffer zone between the Goldsil Repository and the Silver Creek stream channel. The base of the repository toe slope will be lined with a layer of riprap to protect the slope from future meandering of Silver Creek into the repository area.

This work item includes the excavation of approximately 1,250 lineal feet of trench and the installation of geotextile filter fabric and riprap in the trench to protect the repository toe slope. The location of the trenches are shown on Figures 3-28 and 3-39. A two-feet thick layer of Type 2 riprap based on MDEQ-MWCB standard specifications Subsection 530 - Riprap (Montana Department of State Lands, 1991 - Appendix C) will be uniformly placed in the trench. The trench and riprap configuration are shown on Figure 3-7. The riprap shall be obtained from an off-site source. The riprap and filter fabric will extend down the trench slope to an elevation that is at least 1.5 feet below the Silver Creek stream channel bottom to prevent undercutting of the slope by the stream in the event that the stream meanders toward the slope in the future. The trench will be an estimated 6 feet wide. The trench will be excavated such that the riprap will be placed on a 2:1 slope below the repository toe slope. Geotextile filter fabric will be placed beneath the riprap. The filter fabric shall meet the requirements of MDEQ-MWCB standard specifications Subsection 650.02 (C) (Construction Fabric - see Appendix C).

The riprap slope protection trenches will require approximately 630 cubic yards of riprap and 3,110 square yards of filter fabric. The trench and riprap will be backfilled with soil excavated from the trench. Excess soil excavated from the trench shall be graded onto the slope above the trench. The area below the repository toe slope is in the area of a water collection sump and is likely to be wet, which may make the trenching difficult.

3.5.3 Waste Placement and Compaction

Compaction of the mill tailings is critical to the functionality and long-term stability of the repository. Achieving compaction specifications will reduce settlement and enhance the overall stability of the repository. Mill tailings will be compacted in 6 to 12-inch lifts to 90 percent of Standard Proctor (ASTM D-698/AASHTO T 99) maximum dry density at -4 to +4 percent of the optimum moisture content.

Tailings slime (clayey) layers encountered in the waste source areas must be spread in thin layers on the repository and blended with sandy/silty tailings so that the slime layers are not concentrated in any portion of the repository. Excessively wet tailings must be spread to a depth no greater than 1 foot on the repository surface to allow exposure to air and sunlight for adequate time to dry. Debris that is encountered in the waste source areas (i.e., wood and metal debris) must be separated out and disposed of as described in Section 3.3.

3.5.4 Interim Closure

Because of the volume of waste to be removed, the Goldsil repository will require an estimated 3 to 5 years to be completed. At the end of each construction season, the repository will require interim closure to stabilize the compacted tailings and reduce the likelihood of erosion. The exact nature of the interim closure measures will depend on the configuration of the repository at the end of each construction season and will not be designed at this time. The interim closure measures will likely include the following:

- runon controls to limit water entering the repository;
- grading of the repository surface to control drainage;
- construction of lined ditches to drain water from the repository surface without erosion;
- the use of silt fence and/or straw bales to keep sediment from the repository from entering Silver Creek.

3.5.5 Final Closure

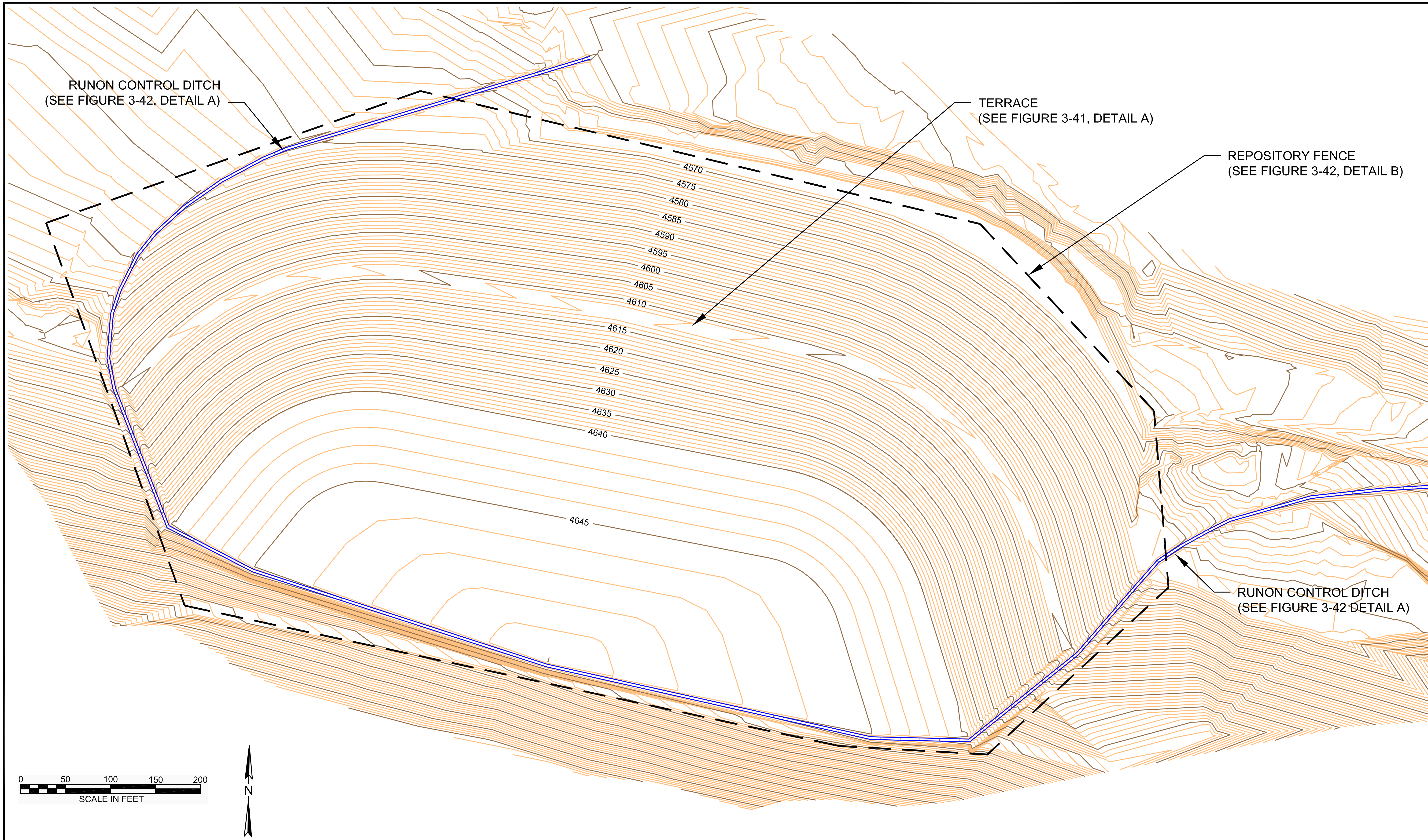
3.5.5.1 Repository Cap

The Goldsil Repository will be unlined (i.e., no base liner) with a multi-layered cap. Figure 3-40 shows the design topography of the repository. The final topography will depend on the actual waste volume that is placed in the repository. The cap system, as presented on Figure 3-41, consists of a geosynthetic clay liner (GCL), a lateral drainage/capillary barrier layer and a vegetative cover soil layer. The repository will be constructed with 4:1 side slopes and a five percent crown slope. A terrace will be constructed at approximately mid-slope to intercept runoff and to provide a location for installing liner anchor trenches. Figure 3-41 shows the terrace dimensions and the GCL anchoring, seaming and patching details.

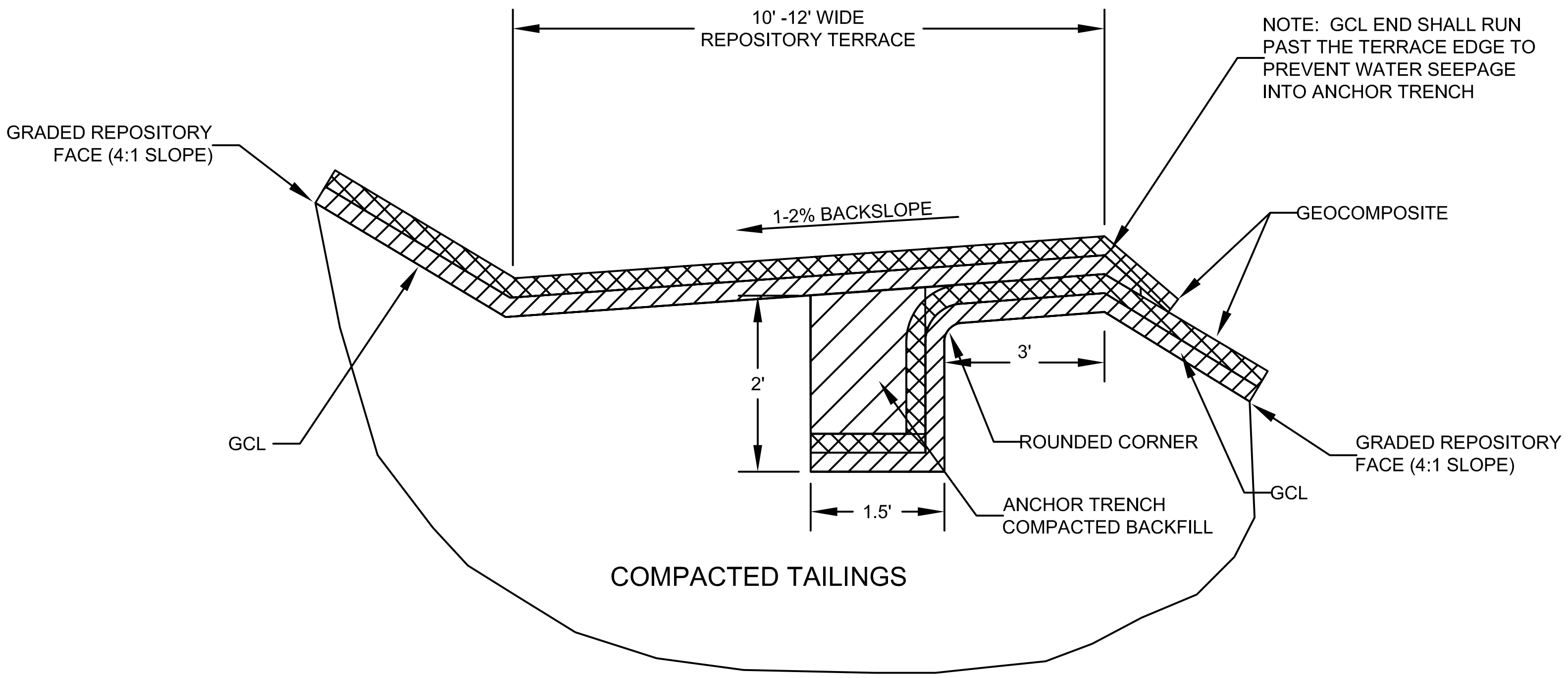
The GCL shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7 m) in length and 15 feet (4.6m) in width. A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

The granular bentonite or bentonite sealing compound used for seaming, penetration sealing and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer. The GCL shall comply with the properties shown in Table 3-3.

The geocomposite drainage layer shall be an integrally formed polyethylene structure consisting of a geonet bonded with filter fabric on both sides. It shall have uniform channels, open area, and thickness to ensure uniform flow throughout the surface. It shall have low compression under loads to maintain a high transmissivity under a range of loading conditions. The geonet shall be resistant to ultraviolet degradation. The geocomposite shall comply with the properties in Table 3-4. The geonet portion of the geocomposite shall comply with the properties shown in Table 3-5. The filter fabric portion of the geocomposite shall comply with the properties shown in Table 3-6.

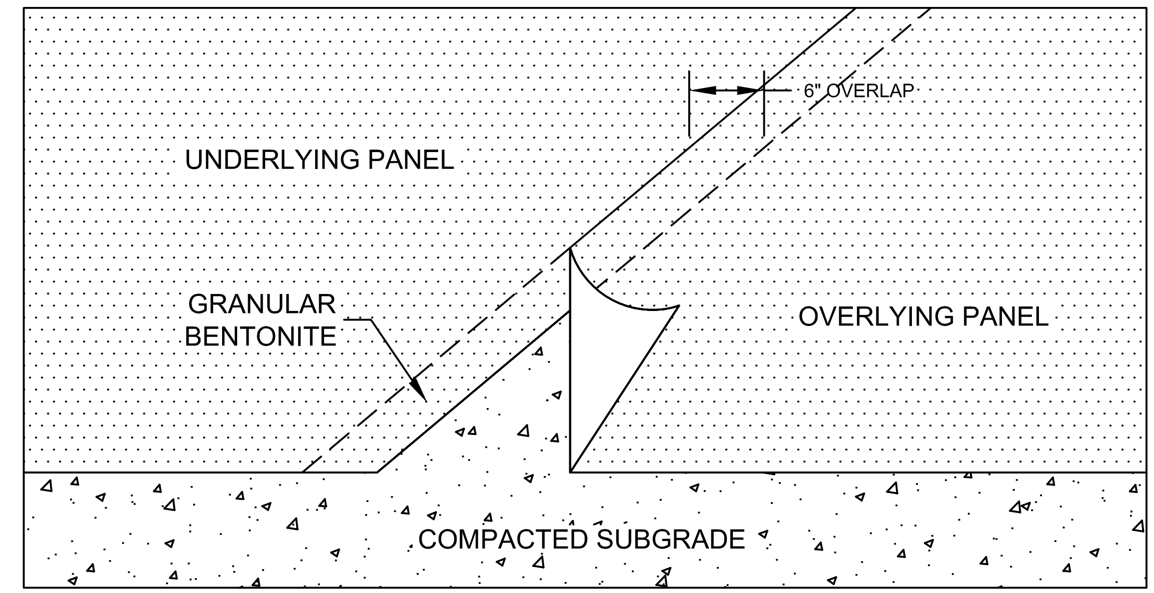


NO.	REVISION DESCRIPTION	BY	DATE	DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA	Olympus Technical Services, Inc.	REPOSITORY DESIGN TOPOGRAPHY	FIGURE 3-40
				APPROVED: KSR	DATE: 6/2004	JOB NO: A1416				
				SCALE: AS SHOWN	FILENAME: A1416GT.dwg					



DETAIL A - GCL/GEOCOMPOSITE TERRACE ANCHOR TRENCH

NOT TO SCALE



DETAIL B - GCL SEAM OVERLAPS

NOT TO SCALE

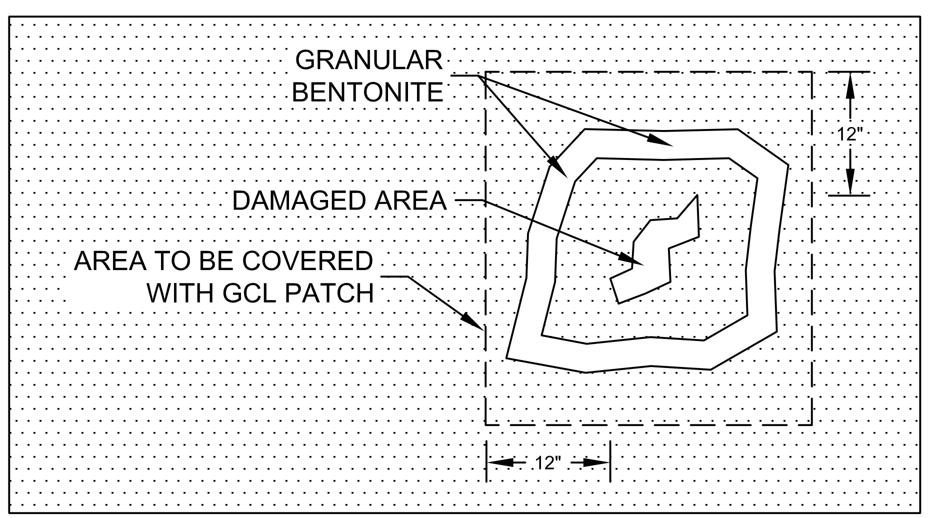
NOTES:
GCL SEAMS ARE CONSTRUCTED BY OVERLAPPING ADJACENT EDGES. SUPPLEMENTAL BENTONITE IS REQUIRED FOR SOME GCLs.

UNLESS OTHERWISE SPECIFIED, THE MINIMUM DIMENSION OF THE LONGITUDINAL OVERLAP SHOULD BE 6 INCHES. END-OF-ROLL OVERLAPPED SEAMS SHOULD BE SIMILARLY CONSTRUCTED, BUT THE MINIMUM OVERLAP IS 24 INCHES.

SEAMS AT THE ENDS OF THE PANELS SHOULD BE CONSTRUCTED SUCH THAT THEY ARE SHINGLED IN THE DIRECTION OF GRADE TO PREVENT THE POTENTIAL FOR RUNOFF FLOW TO ENTER THE OVERLAP ZONE.

END PANEL SEAMS ON THE GRADED DAM FACE SLOPES ARE ONLY PERMITTED ON TERRACES AS SHOWN ON DETAIL A.

BENTONITE ENHANCED SEAMS ARE CONSTRUCTED FIRST BY OVERLAPPING THE ADJACENT PANELS, EXPOSING THE UNDERLYING EDGE, AND THEN APPLYING A CONTINUOUS BEAD OR FILLET OF GRANULAR SODIUM BENTONITE SUPPLIED WITH THE GCL ALONG A ZONE DEFINED BY THE EDGE OF THE UNDERLYING PANEL AND THE 6-INCH OVERLAP. THE MINIMUM APPLICATION RATE AT WHICH THE BENTONITE IS APPLIED IS 1/4 POUND PER LINEAL FOOT.



DETAIL C - GCL LINER PATCH

NOT TO SCALE

NO.	REVISION DESCRIPTION	BY	DATE	DESIGN: KSR	DRAWN: KSR	CHECKED: CRS
				APPROVED: KSR	DATE: 6/2004	JOB NO: A1416
				SCALE: AS SHOWN	FILENAME: A1416GCL.dwg	

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

REPOSITORY CAP DETAILS

FIGURE
3-41

TABLE 3-3 GCL PHYSICAL PROPERTIES

Property	Test Method	Value
Bentonite Swell Index	ASTM D5890	24 ml/2g minimum
Bentonite Fluid Loss	ASTM D5891	18 ml maximum
Bentonite Mass/Area (@ 0% moisture content)	ASTM D5993	0.75 lb/ft^2
GCL Grab Strength	ASTM D4632	90 lb
GCL Peel Strength	ASTM D4632	15 lb
GCL Index Flux	ASTM D5887	1 x 10^{-8} m^3/m/sec
GCL Permeability	ASTM D5084	5 x 10^{-9} cm/sec
GCL Hydrated Internal Shear Strength	ASTM D5321	500 lb/ft^2

TABLE 3-4 GEOCOMPOSITE PHYSICAL PROPERTIES

Property	Test Method	Value (with 4 oz/SY fabric)
Transmissivity	ASTM D 4716	1.1 x 10^{-4} m^2/sec
Average Ply Adhesion	ASTM D413, F	250 gram/inch
Minimum Ply Adhesion	ASTM D413, F	100 gram/inch

TABLE 3-5 GEONET PHYSICAL PROPERTIES

Property	Test Method	Value (with 4 oz/SY fabric)
Transmissivity (at gradient of 1.0, normal load of 4,000 psi)	ASTM D 4716	1.0 x 10^{-3} m^2/sec
Thickness	ASTM D5199	200 mil
Density	ASTM D1505	0.94 g/cm^3
Tensile Strength	ASTM D5034/D5035	32 lb/in
Carbon Black Content	ASTM D1603, modified	2%

TABLE 3-6 GEOTEXTILE FILTER FABRIC PROPERTIES

Property	Test Method	Value (with 4 oz/SY fabric)
Thickness	ASTM D 5199	45 (mil)
Grab Tensile	ASTM D 4632	100 lb
Puncture Strength	ASTM D 4833	65 lb
AOS (U.S. Sieve)	ASTM D 4751	70
Flow Rate	ASTM D 4491	140 gpm/ft^2
UV Resistance	ASTM D4355	70 % retained

3.5.5.2 Seepage Modeling

The effectiveness of the repository cap was evaluated using the EPA Hydrologic Evaluation of Landfill Performance (HELP) model (U.S. EPA, 1997). The Goldsil Repository layer configuration is presented in Table 3-7. Based on a repository capacity of 674,500 cubic yards and a repository area of 12.72 acres, the equivalent tailings thickness is approximately 32.9 feet.

TABLE 3-7 REPOSITORY LAYER CONFIGURATION

Layer No.	Layer Type*	Description	Thickness (inches)	Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Hydraulic Conductivity (cm/sec)
1	1	Cover Soil	18	0.501	0.284	0.135	1.9×10^{-4}
2	2	Lateral Drain	0.25	0.850	0.010	0.005	33.0
3	3	GCL	0.25	0.75	0.747	0.400	3.0×10^{-9}
4	1	Tailings	395	0.398	0.244	0.316	1.2×10^{-4}

*1=Vertical Percolation Layer, 2=Lateral Drainage Layer, 3=Barrier Soil Liner

The HELP model was used to simulate the repository for a period of 30 years after construction of the cap. The simulation was completed using synthetic climate data for Helena, Montana, which is the closest data that is provided with the HELP model. The precipitation and temperature data were calibrated for the Marysville area using mean monthly precipitation. A summary of the HELP model simulation is presented in Table 3-8, and the model output is included in Appendix D. These modeling results show an average precipitation of 15.94 inches per year. An average of 1.196 inches of water per year (7.50 percent) is removed by runoff, while 14.497 (90.95 percent) and 0.161 (1.01 percent) inches of water per year are removed by evapotranspiration and lateral drainage, respectively. An average of 0.00042 inches of water per year is predicted to percolate through the liner and 0.00053 inches of water per year are predicted to percolate from the base of the repository.

As a comparison, the repository was simulated without a cap using the HELP model. A summary of the simulation is presented in Table 3-9, and the model output is included in Appendix E. Compared to the multi-layered cap, these modeling results show a small increase in runoff (1.765 versus 1.196 inches per year) and a small decrease in evapotranspiration (14.054 versus 14.497 inches per year. The predicted percolation from the repository base is 0.039 inches per year versus 0.00053 inches per year for the multi-layered cap. Therefore, over the 30-year simulation period with the same precipitation inputs, the multi-layered cap is predicted to be more than 70 times more effective at reducing percolation from the repository base than if no cap was constructed.

3.5.5.3 Settlement Analyses

Settlement at the repository will occur as a result of consolidation of the foundation soil and consolidation of the wastes placed in the repository. The moisture-density and consolidation test data were used to complete settlement analyses of the repository. The settlement analyses considered the waste layering scenario presented in Section 3.4.2. This scenario includes the following layers from bottom to top:

TABLE 3-8 SUMMARY OF HELP MODEL RESULTS FOR THE GOLDSIL REPOSITORY WITH A MULTI-LAYERED CAP

Year	Precip	Runoff	Evapotran-spiration	Lateral Drainage	GCL Percolation	Tailings Percolation	Change in Storage
1	15.41	0.842	14.383	0.0000	0.000000	0.000000	0.185
2	20.31	0.752	19.388	0.0000	0.000000	0.000000	0.171
3	15.97	1.816	13.026	0.0000	0.000000	0.000000	1.128
4	15.81	1.054	14.937	0.2020	0.001214	0.000000	-0.383
5	13.93	1.291	11.631	0.2140	0.001187	0.001457	0.793
6	13.05	0.624	14.212	0.8460	0.001282	0.002919	-2.635
7	16.72	1.134	13.575	0.0000	0.000000	0.000000	2.011
8	15.10	1.499	13.955	0.0000	0.000000	0.000000	-0.355
9	13.07	0.328	12.070	0.6559	0.001593	0.002934	0.013
10	16.54	0.712	16.244	0.0000	0.000000	0.000000	-0.416
11	14.42	0.694	13.140	0.0000	0.000000	0.000000	0.586
12	16.59	1.420	15.273	0.0000	0.000000	0.000000	-0.103
13	17.10	0.125	16.732	0.0000	0.000000	0.000000	0.243
14	14.57	0.492	14.509	0.0000	0.000000	0.000000	-0.431
15	15.08	0.336	14.737	0.0000	0.000000	0.000000	0.007
16	13.80	0.756	13.520	0.0000	0.000000	0.000000	-0.476
17	16.44	0.426	14.649	0.0000	0.000000	0.000000	1.365
18	13.36	0.788	13.248	1.2372	0.002316	0.004376	-1.918
19	15.09	1.342	13.255	0.0000	0.000000	0.000000	0.493
20	19.66	2.972	16.063	0.1162	0.000809	0.000000	0.509
21	13.59	0.399	12.595	0.0000	0.000000	0.000000	0.596
22	17.42	1.920	15.769	0.3878	0.001124	0.004290	-0.661
23	14.31	2.448	12.498	0.0000	0.000000	0.000000	-0.636
24	16.95	1.550	14.782	0.3283	0.001028	0.000000	0.290
25	16.38	1.133	14.906	0.0000	0.000000	0.000000	0.341
26	16.90	2.358	14.787	0.0000	0.000000	0.000000	-0.246
27	16.59	0.843	15.953	0.0000	0.000000	0.000000	-0.206
28	20.79	1.912	14.848	0.0000	0.000000	0.000000	4.030
29	13.40	2.935	13.452	0.8359	0.001986	0.000000	-3.823
30	19.97	0.989	16.763	0.0000	0.000000	0.000000	2.218
Mean	15.94	1.196	14.497	0.1608	0.000418	0.000533	0.090
St Dev	2.15	0.763	1.627	0.3194	0.000697	0.001291	1.406

TABLE 3-9 SUMMARY OF HELP MODEL RESULTS FOR THE GOLDSIL REPOSITORY WITH NO CAP

Year	Precip	Runoff	Evapotran-spiration	Tailings Percolation	Change in Storage
1	15.41	1.374	13.900	0.000000	0.137
2	20.31	2.078	17.887	0.001528	0.343
3	15.97	2.214	12.723	0.019560	1.013
4	15.81	1.387	14.720	0.011526	-0.308
5	13.93	1.747	11.526	0.001457	0.655
6	13.05	1.267	13.644	0.365063	-2.226
7	16.72	1.754	13.235	0.000000	1.731
8	15.10	2.171	13.349	0.006508	-0.426
9	13.07	1.034	11.858	0.000000	0.178
10	16.54	1.333	15.722	0.000000	-0.516
11	14.42	1.049	12.671	0.018503	0.681
12	16.59	1.936	14.520	0.030316	0.104
13	17.10	1.115	16.049	0.017599	-0.082
14	14.57	1.186	13.870	0.000000	-0.486
15	15.08	0.670	14.190	0.001716	0.219
16	13.80	1.114	13.194	0.000000	-0.508
17	16.44	1.402	14.010	0.000000	1.028
18	13.36	1.211	13.434	0.371689	-1.656
19	15.09	1.694	12.879	0.000000	0.517
20	19.66	3.834	15.353	0.027493	0.446
21	13.59	0.708	12.205	0.016182	0.661
22	17.42	2.437	15.648	0.000000	-0.665
23	14.31	2.595	12.261	0.000000	-0.546
24	16.95	2.249	14.494	0.000000	0.207
25	16.38	1.434	14.347	0.000000	0.599
26	16.90	2.794	14.574	0.001525	-0.470
27	16.59	1.221	15.680	0.000000	-0.312
28	20.79	2.822	14.094	0.000000	3.873
29	13.40	3.140	13.563	0.290109	-3.593
30	19.97	1.988	16.034	0.000000	1.948
Mean	15.94	1.765	14.054	0.039395	0.085
St Dev	2.15	0.752	1.4282	0.103768	1.297

- the Drumlummon millsite tailings (10,570 cy with an equivalent thickness of 1.43 feet);
- the Drumlummon sandy tailings (41,640 cy, with an equivalent thickness of 5.43 feet);
- the Drumlummon clay/slime tailings (18,140 cy, with an equivalent thickness of 2.23 feet);
- the Upper, Middle and Lower Pond area sandy tailings (33,840 cy, with an equivalent thickness of 3.74 feet);
- the Upper, Middle and Lower Pond area clay/slime tailings (16,660 cy, with an equivalent thickness of 1.63 feet);
- the Goldsil Millsite tailings (22,500, with an equivalent thickness of 2.30 feet);
- the Goldsil shallow (0-15 feet) tailings (181,490 cy, with an equivalent thickness of 17.07 feet); and
- the Goldsil deep (15-43 feet) tailings (287,930 cy, with an equivalent thickness of 32.5 feet).

Settlement evaluations of the waste materials were based on the consolidation test data and the expected soil densities based on the moisture-density testing at the specified compaction of 90 percent of standard Proctor. The consolidation data indicate a potential settlement of approximately 1.6 feet of the waste materials based on the combined waste thickness of 66.33 feet at a compaction of 90% of the maximum dry density at the optimum moisture content. Settlement calculations are presented in Appendix F. Table 3-10 provides a summary of the settlement calculation.

3.5.5.4 Slope Stability Analyses

The repository was evaluated for determining whether sliding surfaces may develop which could compromise the repository. The evaluation was conducted using the computer program WINSTABL (Bosscher, 1997). The program determines factors of safety for failure surfaces which are systematically generated throughout the repository. The lowest factor of safety is used for determining the resistance of the repository to sliding failures for the conditions modeled. The modified Bishop Method, which generates circular failure surfaces, was used for the analyses.

Data used in the slope stability model were obtained from the geotechnical testing described in Section 2.1.7. The repository was modeled in static and pseudo-static conditions. Pseudo-static conditions are used to evaluate earthquake effects. A seismic coefficient of 0.1 was in the pseudo-static analyses. Modeling results for the slope stability analyses are presented in Appendix G. The minimum factor of safety for the static and pseudo-static analyses are 2.179 and 1.518, respectively. The minimum allowable factors of safety are 1.5 and 1.3 for static and pseudo-static conditions, respectively (EPA, 1988).

TABLE 3-10 SUMMARY OF SETTLEMENT CALCULATIONS

Layer	Volume (cy)	Equivalent Layer Thickness (feet)	Estimated Settlement (feet)
Goldsil tailings (15-43' deep)	287,930	32.50	0.02
Goldsil tailings (0-15' deep)	181,490	17.07	0.53
Goldsil Millsite tailings	22,550	2.30	0.16
Upper, Middle and Lower Pond area clay/slime tailings	15,660	1.63	0.09
Upper, Middle and Lower Pond area sandy tailings	33,840	3.74	0.10
Drumlummon clay/slime tailings	18,140	2.23	0.33
Drumlummon sandy tailings	41,640	5.43	0.25
Drumlummon millsite tailings	10,570	1.43	0.08
Totals	611,820	66.33	1.56

3.5.5.5 Runon Controls

Runon controls for the repository consist of a runon control ditch that will be constructed around the perimeter of the repository to divert surface water away from the repository. The runon control ditch was designed to accommodate the runoff from the 100-year, 24-hour rainfall. The 100-year, 24-hour rainfall for the project area is 3.0 inches (NOAA, 1973).

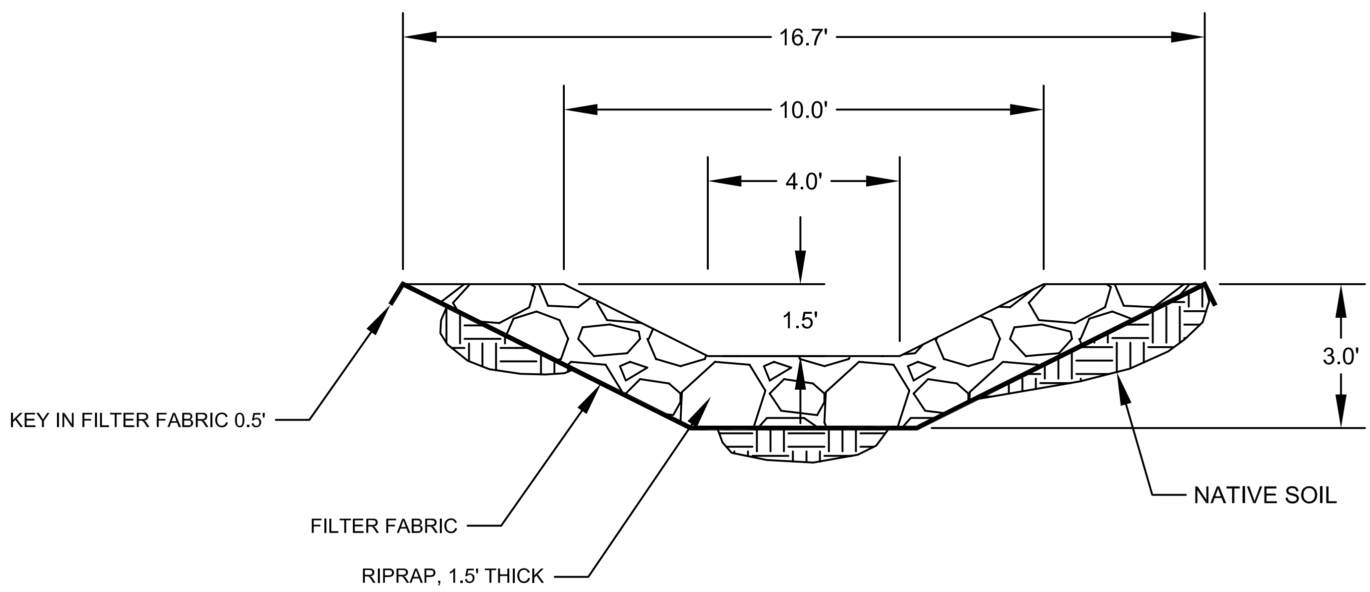
The runoff from the 100-year, 24-hour rainfall was estimated using the USDA Soil Conservation Service TR-55 method (SCS, 1986). The drainage area above the repository is 8.05 acres and the cover type is a woods-grass combination. Based on the surface cover and soil type, a Curve Number of 76 was assigned. Based on these factors, a peak discharge of 9 cfs was calculated using the TR-55 graphical peak discharge method.

The runon control ditch was designed using the Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 15 (FHWA, 1988). Because of the steep slope of the runon control ditch (up to 25 percent slope), riprap was selected as the appropriate lining method. Using the HEC 15 steep slope riprap design procedure, a trapezoidal channel with a 4 foot base width would require riprap with a mean diameter of 0.75 feet. This results in a flow depth of approximately 0.33 feet. Adding freeboard results in a channel that is 1.5 feet deep. The location of the runon control ditch is shown on Figure 3-40. The runon control ditch details are shown on Figure 3-42. Runon control ditch calculations are presented in Appendix H.

The runon control ditch is approximately 2,800 lineal feet and will require 2,250 cubic yards of riprap. The riprap gradation shall be as follows:

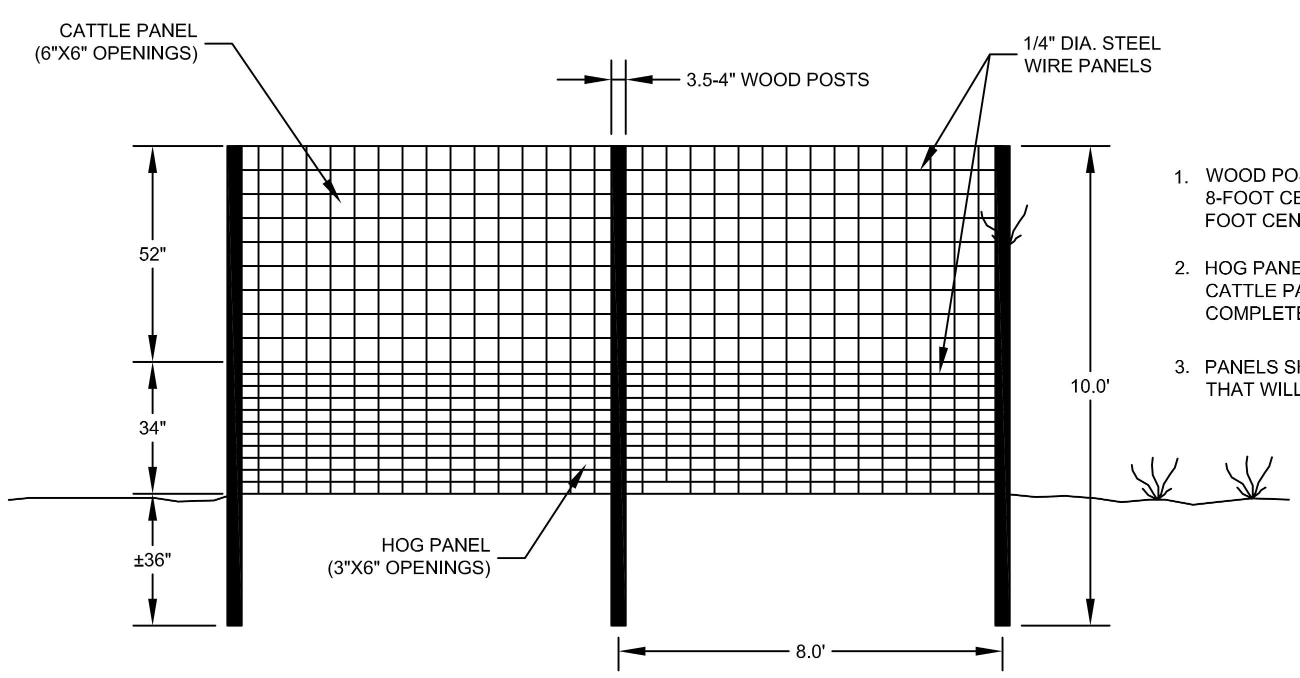
Percent Finer	Rock Size* (feet)
100	1.0
50	0.75
20	0.4
10	0.25

*Equivalent spherical diameter



DETAIL A - RUNON CONTROL DITCH

NOT TO SCALE



1. WOOD POSTS (TREATED, POINTED, CAPPED) PLACED ON 8-FOOT CENTERS WITH EACH POST SET APPROXIMATELY ON 8 FOOT CENTERS INTO THE GROUND
2. HOG PANELS PLACED ON LOWER PART OF THE FENCE. CATTLE PANELS PLACED ABOVE THE HOG PANEL TO COMPLETE THE 7.2 FEET HIGH FENCE.
3. PANELS SHALL BE SECURED TO THE POSTS BY A METHOD THAT WILL BE DURABLE.

DETAIL B - REPOSITORY FENCE

NOT TO SCALE

Olympus Technical Services, Inc.				MONTANA DEQ/MINE WASTE CLEANUP BUREAU SILVER CREEK DRAINAGE PROJECT LEWIS & CLARK COUNTY, MONTANA		RUNON CONTROL DITCH AND REPOSITORY FENCE DETAILS	FIGURE 3-42
DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: NONE	FILENAME: A1416Runon.dwg

The runon control ditch shall be lined with a 1.5-foot thick layer of riprap. The riprap shall be comprised of angular rock and shall be obtained from a suitable off-site source. A layer of geotextile filter fabric shall be placed beneath the riprap. The filter fabric shall meet the requirements of MDEQ-MWCB standard specifications Subsection 650.02 (C) (Construction Fabric - see Appendix C). Approximately 5,640 square yards of geotextile filter fabric will be required.

The geotextile shall be placed on a smooth graded surface. The geotextile shall be placed in such a manner that it will not excessively stretch or tear upon placement of the overlying materials. Care should be taken to place the geotextile in intimate contact with the soil such that no void spaces exist between the underlying soil and the geotextile. Anchoring of the geotextile shall be accomplished though the use of key trenches or aprons at the crest of the slope according to the manufacturers specifications. Riprap placement shall begin across the channel bottom at the toe and proceed up each side slope. Riprap shall not be dropped onto the geotextile from a height exceeding 1 foot.

3.5.5.6 Revegetation

Upon placement of the cover soil, the repository surface will be seeded, fertilized, and mulched. The revegetation will be completed in accordance with MDEQ-MWCB standard specifications Subsection 320 - Fertilizing and Seeding and Subsection 330 - Mulching (Appendix C). Seed and fertilizer will be applied by drill seeding. The seed mix for the waste source areas, repository, borrow source areas and other disturbed areas is presented in Table 3-11. A similar seed mix was successfully used in the reclamation of the Empire Mine and Millsite in 1997. The Empire Mine and Millsite is located on the west side of Mount Belmont, approximately 3 miles west of Marysville. The site is at a similar elevation as the Marysville area.

Straw mulch shall be applied to the repository area at a rate of 3,000 pounds per acre. Straw mulch shall be anchored by a mulch tiller (crimper). Equipment used to spread straw shall not chop or otherwise decrease the effective length of the applied mulch.

3.5.5.7 Fencing

A woven-wire fence shall be constructed around the repository to limit access. The woven-wire repository fence is shown on Figures 3-40 and 3-42. Approximately 3,150 lineal feet of cattle/hog-wire fence will be constructed to enclose the repository. The finished height of the cattle/hog-wire fence shall be a minimum of 7.2 feet. The fence shall surround the repository area and shall be at least ten (10) feet outside of the repository boundary. No gates will be constructed as part of the repository fence enclosures; rather, the wire panels will terminate on a post in a selected location where the panels can be removed to allow easy access for personnel for monitoring and/or maintenance of the reclaimed areas. The work includes, but is not limited to the following:

- all layout, grading, and clearing necessary to efficiently and properly construct the cattle/hog-wire fence; and

- furnishing and installing cattle and hog wire, wood posts and tie wire as specified.

TABLE 3-11 SEED MIX FOR THE REPOSITORY, WASTE SOURCE AREAS, BORROW AREAS AND ALL OTHER DISURBED AREAS

Scientific Name	Common Name	lbs PLS/ acre1,2
	Grasses	
Poa compressa	Canada Bluegrass	0.5
Agrostis alba	Red Top	0.5
Elymus trachycaulus ssp. Trachycaulus	Slender Wheatgrass	8
Festuca idahoensis	Idaho Fescue	5
Subtotal		**14.0**
	Forbs	
Achillea millefolium	White Yarrow	0.5
Trifolium repens	White Dutch Clover	0.5
Subtotal		**1.0**
Total		**15.0**

Notes: 1. PLS = Pure Live Seed
2. Reported rates are for drill seeding; rates shall be doubled for hydraulic and broadcast seeding.

3.6 WASTE SOURCE RECLAMATION

3.6.1 Revegetation

The waste removal areas, reconstructed stream banks, floodplain, borrow areas, temporary haul roads, staging areas, and other disturbed areas will be seeded, fertilized, and mulched. Seed and fertilizer will be applied by drill seeding, hydroseeding, or broadcast methods, as appropriate for the conditions. Slopes steeper than 2.5H:1V will be hydroseeded and hydromulched. The revegetation will be completed in accordance with MDEQ-MWCB standard specifications Subsection 320 - Fertilizing and Seeding and Subsection 330 - Mulching (Appendix C). The seed mix for the waste source areas, borrow source areas and other disturbed areas is presented in Table 3-11. The seed mix for the reconstructed stream channel and floodplain is presented in Table 3-12.

Certified weed free straw mulch or wood fiber mulch and tackifier (hydromulch) shall be applied to seeded areas. For slopes less steep than 2.5:1, crimping shall be used as the mulch anchoring mechanism. For slopes steeper than 2.5:1 , hydromulch shall be applied.

Straw mulch shall be applied at a rate of 3,000 pounds per acre in those areas which are to be drill or broadcast seeded. Straw mulch shall be anchored by a mulch tiller (crimper). Equipment used to spread straw shall not chop or otherwise decrease the effective length of the applied mulch.

Wood fiber mulch shall be applied at a rate of 2,000 pounds per acre in those areas which are to be hydroseeded. Wood fiber mulch shall be applied concurrently with a non-asphaltic tackifier on all hydromulched areas at the manufacturer's recommended rate (or a minimum of 40 pounds per acre for slopes flatter than 2:1 and 80 pounds per acre for slopes 2:1 or steeper).

TABLE 3-12 SEED MIX FOR RECONSTRCUTED STREAM CHANNEL AND FLOODPLAIN

Scientific Name	Common Name	lbs PLS/ acre1,2
	Grasses	
Deschampia caespitosa	Tuffed Hairgrass	1.25
Calamagrostis canadensis	Bluejoint Reedgrass	1.75
Festuca idahoensis	Idaho Fescue	2.0
Elymus lanceolatus ssp. Riparium	Streambank Wheatgrass	5.0
Subtotal		10.0
	Forbs	
Achillea millefolium	White Yarrow	0.25
	Regreen	8.5
Subtotal		8.75
Total		18.75

Notes: 1. PLS = Pure Live Seed
2. Reported rates are for drill seeding; rates shall be doubled for hydraulic and broadcast seeding.

3.6.2 Fencing

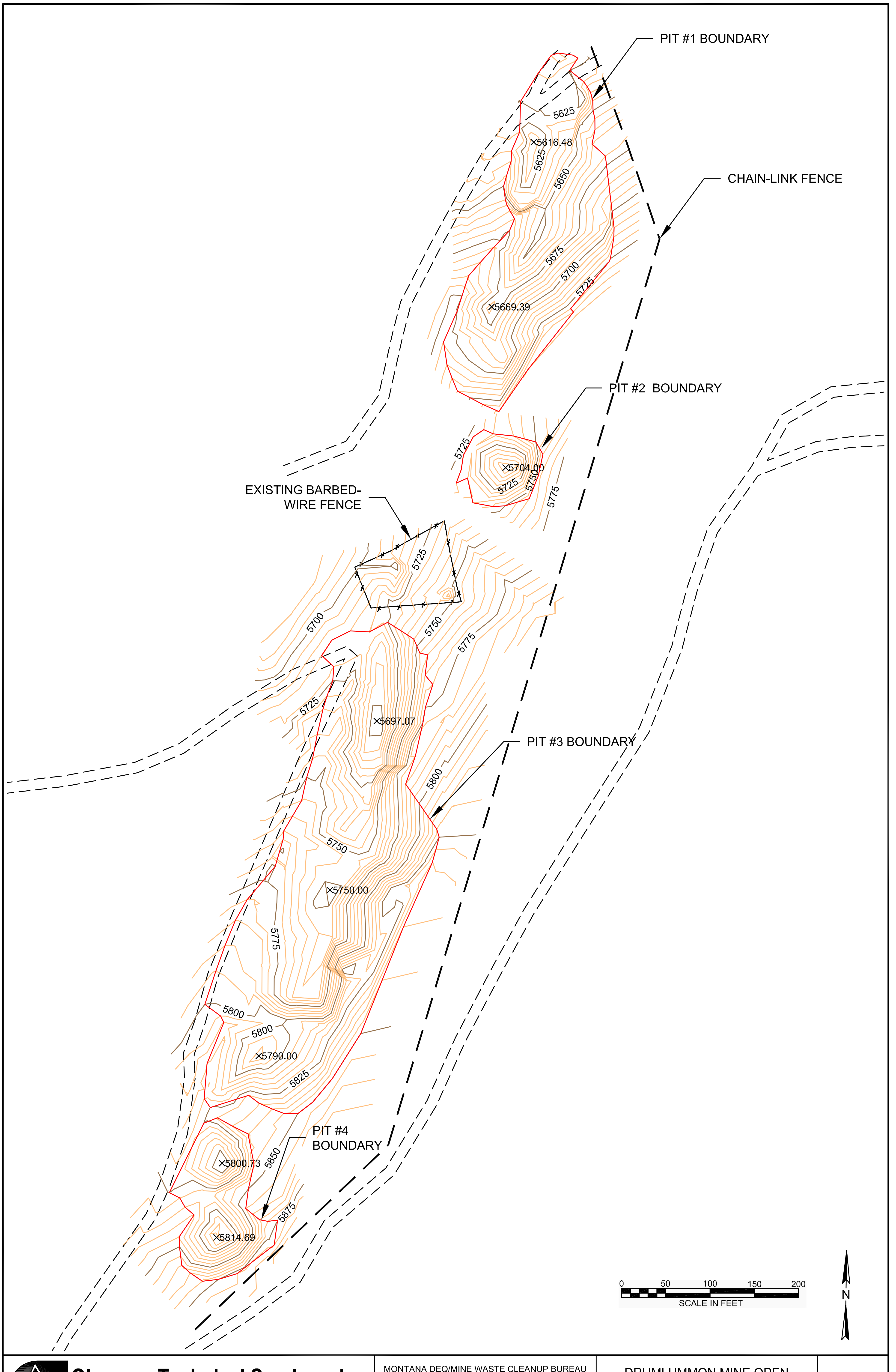
Barbed-wire fencing will be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. The type of fence shall be 4-strand barbed wire with metal posts around the excavated waste source areas, borrow areas, and staging areas. Each 4-strand, barbed-wire fence enclosure will have a single gate constructed according to the DEQ-MWCB standard specification subsection 520 - Farm Fence (Type F-4 - see Appendix C).

3.7 DRUMLUMMON OPEN PITS

A series of large open cut pits with very steep highwalls on the upslope side are located above the Drumlummon mill area. The upslope area is forested and has no fencing and only limited signs are present to warn of the highwall hazard. Figure 3-43 shows the existing topography of the open pits and associated highwalls. There are a total of four open pit areas, labeled Pit #1, Pit #2, Pit #3 and Pit #4 (Figure 3-43). The maximum height of the highwalls associated with each of the open pits are 80 feet, 56 feet, 100 feet and 65 feet for Pit #1, Pit #2, Pit #3 and Pit #4, respectively. The approximate chain-link fence quantity is 1,600 lineal feet.

A chain-link fence and warning signs will be installed on the upslope side of the highwalls to warn passersby of the highwall hazard. The chain-link fence will be installed according to MWCB standard specification Subsection 524 - Chain-Link Fence (Appendix C).

The fence shall be 8-feet high with three strands of barbed wire installed above the top of the chain link as shown in standard specification Subsection 524 (Appendix C). Shallow rock is present at or near the surface along the entire alignment of the fence and may require drilling to install fence posts. The work to install the fence will include:



Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

DRUMLUMMON MINE OPEN PIT FENCING AREA

FIGURE 3-43

DESIGN: KSR	DRAWN: KSR	CHECKED: CRS	APPROVED: KSR	DATE: 6/2004	JOB NO: A1416	SCALE: AS SHOWN	FILENAME: A1416pits.dwg

- layout, grading, and clearing necessary to efficiently and properly construct the fences;
- digging or drilling fence post holes into the existing surface;
- furnishing and installing metal posts, chain-link fence fabric, barbed wire, rails, braces, and fittings as specified; and
- installing warning signs provided by the DEQ-MWCB on the chain-link fence.

OHSA requirements for fall protection for construction (29 CFR Part 1926, Subpart M) require that workers working at the edge of an excavation, pit or shaft 6 or more feet in depth must be protected from falling by appropriate measures. The Contractor who completes the work will be required to address fall protection issues related to installation of the fence near the highwall.

4.0 ESTIMATED COSTS

Because of the size of the Silver Creek Drainage Project, it has been estimated that 3 to 5 construction phases will be required to complete the work. The estimated costs for 5 construction phases are presented in Table 4-1. The work sequence generally follows the construction sequencing as discussed in Section 3.4.2. Since the level of funding for the project is currently unknown, a goal was to generally keep the costs to less than $1,000,000 per phase, while still maintaining logical work sequences (i.e., completing the project by specific waste groups). As shown on Table 4-1, the estimated costs range from approximately $792,000 to $1,325,000. The estimated cost of Phase 5 is larger than the other phases because of the costs associated with capping the repository. The total estimated construction cost for the five phases is $4,790,329.

Table 4-2 provides the estimated costs for completing the work in 3 construction seasons. Under this scenario, the construction cost per phase ranges from approximately $1,543,000 to $1,624,000. The total estimated construction cost is $4,790,329.

5.0 CONSTRUCTION SCHEDULE

The construction schedule will primarily be determined by the level of funding that is available each year to allocate to the project. The project has been set up to be completed in three to five separate construction phases to allow MWCB flexibility in allocating funding to the project. Because of the need to leave the repository open until all wastes have been placed, it is advisable that the project be completed in consecutive years; however, this is not mandatory. Interim repository closure measures (Section 3.5.4) would be implemented after each construction season prior to final closure of the repository to limit erosion from the repository.

A separate bid specification package would be prepared for each phase of work to allow DEQ-MWCB to solicit bids and retain a contractor to complete the work for a given construction phase. The bid package should be completed by March of each year to allow DEQ-MWCB time to advertise, solicit bids and award a contract so that work could start as early as June of each year. In a typical year, construction should be able to proceed through October, however, this will vary depending on the weather conditions. This should allow for 4 or 5 months of construction time for each phase.

Table 4-1. Cost Estimate for Five Phases of Construction for the Silver Creek Drainage Projec

Task	Quantity	Units	Unit $	Cost $	Comment
Phase 1 Construction					
Mobilization, Bonding & Insurance	$778,627	%	8%	$62,290	
Access Road Improvement	5,200	LF	1.00	$5,200	
Repository Construction					
Repository Clearing and Grubbing	12.7	Acre	1000	$12,700	
East Goldsil Tailings Removal	11,020	CY	2.5	$27,550	
Lined Pond Tailings Removal	10,990	CY	2.5	$27,475	
Repository Base Preparation	28,250	CY	3.00	$84,750	
Ramp Soil Pile Removal	4,750	CY	3.00	$14,250	
Silver Creek Temporary Stream Diversion					
Tailings Removal	9,120	CY	4.30	$39,216	
Ditch Excavation	1,960	CY	2.00	$3,920	
Ditch Lining (erosion control mat)	2,600	SY	3.00	$7,800	
Waste Load, Haul & Dump					
Drumlummon Millsite Tailings	10,570	CY	6.90	$72,933	
Drumlummon Tailings	50,660	CY	4.30	$217,838	
Waste Grading and Compaction	92,360	CY	2.00	$184,720	
Silver Creek Stream Reconstruction					
Stream Channel Construction	1,350	LF	10.00	$13,500	
Floodplain Grading	4.10	Acres	1000.00	$4,100	
Install Willows	1,350	Each	3.00	$4,050	
Revegetation					
Seed/Fertilize	8.06	Ac	1,000	$8,062	
Mulch	8.06	Ac	1,000	$8,062	
Fencing					
Barbed-wire Fence	4,200	LF	2.50	$10,500	
Open Pit Chain Link Fencing	1,600	LF	20.00	$32,000	
Phase 1 Construction Total				$840,917	
Phase 2 Construction					
Mobilization, Bonding & Insurance	733,655	%	8%	$58,692	
Access Road Improvement	6,400	LF	1.00	$6,400	
Debris Removal and Disposal	1	LS	100000	$100,000	
Waste Load, Haul & Dump					
Upper Pond Tailings	20,720	CY	4.20	$87,024	
Middle Pond Tailings	11,110	CY	4.30	$47,773	
Lower Pond Tailings	17,670	CY	4.40	$77,748	
Goldsill Millsite Tailings	22,550	CY	2.50	$56,375	
Waste Grading and Compaction	72,050	CY	2.00	$144,100	
Waste Source Grading	48,360	CY	3.00	$145,080	
Revegetation					
Seed/Fertilize	25.08	Ac	1,000	$25,078	
Mulch	25.08	Ac	1,000	$25,078	
Fencing					
Barbed-wire Fence	7,600	LF	2.50	$19,000	
Phase 2 Construction Total				$792,348	
Phase 3 Construction					
Mobilization, Bonding & Insurance	$822,582	%	8%	$65,807	
Waste Load, Haul & Dump					
Goldsil Tailings	180,000	CY	2.50	$450,000	
Waste Grading and Compaction	180,000	CY	2.00	$360,000	
Revegetation					
Seed/Fertilize	6.29	Ac	1,000	$6,291	
Mulch	6.29	Ac	1,000	$6,291	
Phase 3 Construction Total				$888,388	

Table 4-1. Cost Estimate for Five Phases of Construction for the Silver Creek Drainage Projec

Task	Quantity	Units	Unit $	Cost $	Comment
Phase 4 Construction					
Mobilization, Bonding & Insurance	$858,272	%	8%	$68,662	
Waste Load, Haul & Dump					
Goldsil Tailings	180,000	CY	2.50	$450,000	
Waste Grading and Compaction	180,000	CY	2.00	$360,000	
Repository Toe Riprap Protection					
Trench Excavation	1,250	LF	6.00	$7,500	
Geotextile Filter Fabric	3,110	SY	4.00	$12,440	
Riprap	630	CY	25.00	$15,750	
Revegetation					
Seed/Fertilize	6.29	Ac	1,000	$6,291	
Mulch	6.29	Ac	1,000	$6,291	
Phase 4 Construction Total				$926,933	
Phase 5 Construction					
Mobilization, Bonding & Insurance	$1,227,624	%	8%	$98,210	
Waste Load, Haul & Dump					
Goldsil Tailings	87,410	CY	2.50	$218,525	
Waste Grading and Compaction	87,410	CY	2.00	$174,820	
Repository Cap Construction					
Install Geosynthetic Clay Liner	62,780	SY	4.50	$282,510	
Install Geocomposite Drainage Layer	62,780	CY	4.50	$282,510	
Cover Soil					
BS-1	13,930	CY	4.30	$59,899	
BS-2	17,460	CY	4.10	$71,586	
Terrace Erosion Control Mat	1,400	SY	3.00	$4,200	
Water Diversion/Runon Controls					
Run-on Control Ditch	2,800	LF	2.00	$5,600	
Riprap	2,250	CY	25.00	$56,250	
Revegetation					
Seed/Fertilize	19.26	Ac	1,000	$19,262	
Mulch	19.26	Ac	1,000	$19,262	
Fencing					
Barbed-wire Fence	5,600	LF	2.50	$14,000	
Repository Fence	3,200	LF	6.00	$19,200	
Phase 5 Construction Total				$1,325,834	
Subtotal				$4,774,420	
Construction Oversight	15%			$716,163	
Subtotal Capital Costs				$5,490,583	
Contingency	10%			$549,058	
TOTAL CAPITAL COSTS				$6,039,641	
POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	1	/Year	250	$250	
Sampling & Analysis	4	/Year	200	$800	
Maintenance	1	L.S.	1500	$1,500	
Subtotal				$2,550	
Contingency	10%			$255	
TOTAL ANNUAL O&M COST				$2,805	
TOTAL CAPITAL COSTS				$6,039,641	
PRESENT WORTH O&M COST	30	yrs @	10%	$26,442	
TOTAL PRESENT WORTH COST				$6,066,084	

Table 4-2. Cost Estimate for Three Phases of Construction for the Silver Creek Drainage Project

Task	Quantity	Units	Unit $	Cost $	Comment
Phase 1 Construction					
Mobilization, Bonding & Insurance	$1,502,877	%	8%	$120,230	
Access Road Improvement	11,600	LF	1.00	$11,600	
Debris Removal and Disposal	1	LS	100000	$100,000	
Repository Construction					
Repository Clearing and Grubbing	12.7	Acre	1000	$12,700	
East Goldsil Tailings Removal	11,020	CY	2.5	$27,550	
Lined Pond Tailings Removal	10,990	CY	2.5	$27,475	
Repository Base Preparation	28,250	CY	3.00	$84,750	
Ramp Soil Pile Removal	4,750	CY	3.00	$14,250	
Silver Creek Temporary Stream Diversion					
Tailings Removal	9,120	CY	4.30	$39,216	
Ditch Excavation	1,960	CY	2.00	$3,920	
Ditch Lining (erosion control mat)	2,600	SY	3.00	$7,800	
Waste Load, Haul & Dump					
Drumlummon Millsite Tailings	10,570	CY	6.90	$72,933	
Drumlummon Tailings	50,660	CY	4.30	$217,838	
Upper Pond Tailings	20,720	CY	4.20	$87,024	
Middle Pond Tailings	11,110	CY	4.30	$47,773	
Lower Pond Tailings	17,670	CY	4.40	$77,748	
Goldsill Millsite Tailings	22,550	CY	2.50	$56,375	
Waste Grading and Compaction	164,410	CY	2.00	$328,820	
Waste Source Grading	48,360	CY	3.00	$145,080	
Silver Creek Stream Reconstruction					
Stream Channel Construction	1,350	LF	10.00	$13,500	
Floodplain Grading	4.10	Acres	1000.00	$4,100	
Install Willows	1,350	Each	3.00	$4,050	
Revegetation					
Seed/Fertilize	31.06	Ac	1,000	$31,062	
Mulch	31.06	Ac	1,000	$31,062	
Fencing					
Barbed-wire Fence	9,700	LF	2.50	$24,250	
Open Pit Chain Link Fencing	1,600	LF	20.00	$32,000	
Phase 1 Construction Total				$1,623,107	
Phase 2 Construction					
Mobilization, Bonding & Insurance	$1,413,968	%	8%	$113,117	
Waste Load, Haul & Dump					
Goldsil Tailings	300,000	CY	2.50	$750,000	
Waste Grading and Compaction	300,000	CY	2.00	$600,000	
Repository Toe Riprap Protection					
Trench Excavation	1,250	LF	6.00	$7,500	
Geotextile Filter Fabric	3,110	SY	4.00	$12,440	
Riprap	630	CY	25.00	$15,750	
Revegetation					
Seed/Fertilize	11.51	Ac	1,000	$11,514	
Mulch	11.51	Ac	1,000	$11,514	
Fencing					
Barbed-wire Fence	2,100	LF	2.50	$5,250	
Phase 2 Construction Total				$1,527,085	
Phase 3 Construction					
Mobilization, Bonding & Insurance	$1,503,915	%	8%	$120,313	
Waste Load, Haul & Dump					

Table 4-2. Cost Estimate for Three Phases of Construction for the Silver Creek Drainage Project

Task	Quantity	Units	Unit $	Cost $	Comment
Goldsil Tailings	147,410	CY	2.50	$368,525	
Waste Grading and Compaction	147,410	CY	2.00	$294,820	
Repository Cap Construction					
Install Geosynthetic Clay Liner	62,780	SY	4.50	$282,510	
Install Geocomposite Drainage Layer	62,780	CY	4.50	$282,510	
Cover Soil					
BS-1	13,930	CY	4.30	$59,899	
BS-2	17,460	CY	4.10	$71,586	
Terrace Erosion Control Mat	1,400	SY	3.00	$4,200	
Water Diversion/Runon Controls					
Run-on Control Ditch	2,800	LF	2.00	$5,600	
Riprap	2,250	CY	25.00	$56,250	
Revegetation					
Seed/Fertilize	22.41	Ac	1,000	$22,407	
Mulch	22.41	Ac	1,000	$22,407	
Fencing					
Barbed-wire Fence	5,600	LF	2.50	$14,000	
Repository Fence	3,200	LF	6.00	$19,200	
Phase 5 Construction Total				$1,624,228	
Subtotal				$4,774,420	
Construction Oversight	15%			$716,163	
Subtotal Capital Costs				$5,490,583	
Contingency	10%			$549,058	
TOTAL CAPITAL COSTS				$6,039,641	
POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	1	/Year	250	$250	
Sampling & Analysis	4	/Year	200	$800	
Maintenance	1	L.S.	1500	$1,500	
Subtotal				$2,550	
Contingency	10%			$255	
TOTAL ANNUAL O&M COST				$2,805	
TOTAL CAPITAL COSTS				$6,039,641	
PRESENT WORTH O&M COST	30	yrs @	10%	$26,442	
TOTAL PRESENT WORTH COST				$6,066,084	

6.0 DRAWINGS AND SPECIFICATIONS

Material specifications for the Drumlummon tailings diversion ditch, stream reconstruction materials, repository cap construction materials, runon control ditch, seed, fertilizer and mulch, and fencing materials have been included in Section 3 with the design discussion of each of those components. Construction specifications for waste placement and compaction have been included in the design discussion in Section 3. Since the project will be completed in several phases, a bid specification package will be prepared for each construction phase. The detailed written specifications and design drawings for each phase will be included in the specific bid specification package for each construction phase.

7.0 OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan will be developed for the site after completion of the reclamation. The O&M plan will document the duration and frequency of site inspections and monitoring, inspection procedures, maintenance requirements, sampling and analysis requirements and procedures, and reporting requirements. As-built drawings of the site, showing the pertinent features and sampling locations will be included in the plan.

The following is a proposed outline for the O&M plan.

- 1.0 Introduction
    - 1.1 Objective
    - 1.2 Location
    - 1.3 Background
    - 1.4 Ownership and Contact
- 2.0 Summary of Reclamation Actions
- 3.0 Inspection and Maintenance Requirements
    - 3.1 Inspection Objectives and Schedule
        - 3.1.1 Revegetation Success
        - 3.1.2 Noxious Weed Conditions
        - 3.1.3 Erosion Conditions
        - 3.1.4 Water Runon/Runoff Controls
        - 3.1.5 Security Structures
        - 3.1.6 Site Water Conditions
        - 3.1.7 Parking Area
    - 3.2 Maintenance Requirements
- 4.0 Sampling and Analytical Requirements
    - 4.1 Sampling Objectives and Schedule
- 5.0 Reporting Requirements
- 6.0 References
- Appendix A - Reclaimed Mine Site Inspection Checklist

8.0 REFERENCES

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APPENDIX A

GEOTECHNICAL TESTING DATA REPORTS

APPENDIX B

HEC-RAS MODELING RESULTS FOR THE RECONSTRUCTED DRUMLUMMON TAILINGS STREAM CHANNEL

APPENDIX C

MONTANA DEPARTMENT OF STATE LANDS ABANDONED MINE RECLAMATION BUREAU STANDARD SPECIFICATIONS FOR ABANDONED MINE RECLAMATION CONSTRUCTION

APPENDIX D

HELP MODEL RESULTS FOR THE SILVER CREEK/GOLDSIL REPOSITORY WITH A MULTI-LAYERED CAP

APPENDIX E

HELP MODEL RESULTS FOR THE SILVER CREEK/GOLDSIL REPOSITORY WITH NO CAP

APPENDIX F

REPOSITORY SETTLEMENT CALCULATIONS

APPENDIX G

REPOSITORY SLOPE STABILITY MODELING RESULTS

APPENDIX H

RUNON CONTROL DITCH CALCULATIONS